ASSESSING THE ECONOMIC BENEFITS OF COOPERATION AMONG SMALL FOREST OPERATORS

A Thesis

Submitted to the College of Graduate Studies and Research

in Partial Fulfillment of the Requirements

for the Degree of

Master of Science

In the Department of

Bioresource Policy, Business, and Economics

University of Saskatchewan

by

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ABSTRACT

Vermette, Matthew, M.Sc. University of Saskatchewan, Saskatoon, September 2013.
Assessing the Economic Benefits of Cooperation Among Small Forest Operators.
Supervisor: Hayley Hesseln

The independent operators (IOs) are small forest operators with timber allocation volumes in Saskatchewan under 20,000 m^3. Due to their scale, this group is characterized by above- average industry wood procurement and transaction costs. In the past, IO's above average costs were compensated by above average market prices for the products they produce and limited competition. In recent years, increased competition confounded by low demand and low prices, as well as rapidly increasing operating costs have made it necessary for IOs to restructure operations to reduce costs and increase competitiveness.

This thesis investigates the benefits of restructuring IOs using a cooperative business model to help reduce costs, eliminate competitive inefficiencies within the industry, and create economies of scope in IO fibre procurement activities and fibre utilization. Within the literature review, numerous cooperative models used in the forest and agriculture industries and the advantages and disadvantages associated with each cooperative type are explored. Next, the potential economic benefits of restructuring IOs under the new generation cooperative model are examined using a comparative economic analysis of the business as usual fibre procurement cost model and IO NGC fibre procurement cost model derived within this study. Data obtained from an IO case study and interviews with IO industry representatives is fitted to the models to generate fibre procurement cost data for each model. The resulting fibre procurement cost values for each model are then compared and further examined using sensitivity and breakeven analysis.

The results of this analysis reveal that the new generation cooperative model has the potential to provide significant economic benefits to IOs through the creation of economies of scope in harvesting costs, but has little effect on the six other costs that make are included in fibre procurement costs. The analysis also reveals that so long as the NGC consist of IOs that require both large and small diameter fibre, the IO NGC has the potential to provide significant economies of scope in fibre utilization.

ACKNOWLEDGEMENTS

Many people have contributed to the success of this study and my education, I apologize in advance to anyone that I forget to acknowledge.

To my parents for all of their support over the many years that my education has spanned. Whether it was emotional or financial support you were always there. To my mom for always being my voice of reason and helping me to see the big picture instead of all the tiny parts that I sometimes tend to focus on. To my dad who planted a seed in my mind at a young age that going to university was my destiny and then provided me with all the tools to get there and succeed.

To my partner Sam Hadden, thank you for all of the emotional support that you have given me over the years. Your willingness to take on just a bit more of the daily chores, cook that extra meal, or just be my sounding board really made all the difference in the world. I know that without your support I would have never been able to build a business, complete my degree, and maintain some semblance of a life all at the same time. Most of all thank you for all of the love and good laughs when the going got a little rough and I needed it most.

To Hayley Hesseln, for being an academic to whom I can aspire to. You have been my academic mentor since the day we met. You have given me the opportunity to do what I love and taught me how to do it just a little bit better along the way. Whenever I approach a problem, I will always hear the words "think like an economist" in my mind. You truly have taught me to think like an economist, which for someone in our line of work is kind of the point. Even more importantly, you were someone that I could relate to and provided me with a sense of belonging in the department. For all of these things, I truly thank you.

To Joel Bruneau, for all of the wisdom and guidance you have provided me with from the moment I stepped into my first resource economics class. You have a unique gift of teaching economics in a way that just makes sense and I owe my understanding of many of the important concepts in my discipline to you. Thank you for helping to build a strong foundation in economics in my mind and caring enough to follow up on it by becoming part of my grad committee. Every time we talk I learn something new and see things just a bit differently.

To David Natcher for taking the time to review my work and become a part of my graduate committee. It is a big commitment and I am honored that you chose to share some of your time with me. While our time together in my program was limited, I certainly learned some valuable lessons surrounding cultural values and collective action in resource management through our interaction together. The concepts surrounding aboriginal resource management and cultural values present in your body of work have been influential in much of my professional work in Metis communities.

A special thanks to the Government of Saskatchewan for funding this project. Without your funding this study would not have been possible. While there are many people within government who contributed to obtaining funding or providing information relevant to the project, I wanted to take a moment to acknowledge the individuals that were directly involved, including Bob Ruggles, Charene Miller, Barb Janke, Chris Brown, and Jim Smith.

Finally, a special thanks to the management and staff of Vermette Wood Products Ltd. and Daryl Sande and Perry Vermette of the Independent Forest Operators of Saskatchewan. Your input, information, and support were invaluable in completing this study. May all of the Independent Forest Operators of Saskatchewan prosper well into the future.

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CHAPTER 1: INTRODUCTION

1.0 **Introduction to the Independent Operators (IOs)**

The independent operators (IOs) are small forest businesses with fibre allocation volumes in Saskatchewan forests ranging from 500 m^3 to 20,000 m^3. While a small minority of IOs are strictly logging firms, the vast majority produce forest products ranging from dimensional lumber, timbers, and railway ties to more specialized products such as flooring, paneling, treated fence posts, utility poles and high quality construction logs. This is vastly different from other areas of Canada with a large IO presence; e.g. Northern Ontario, where the majority of IOs are logging firms who do not engage in value added product manufacturing, but rather sell fibre to larger mills (Harrison, 2009).

IOs have been operating within Saskatchewan's forest industry for over 100 years and, as such, are an important component of the province's heritage. In fact, many of the IOs are family owned companies that have been operating for generations. Despite their history in the forest sector, IOs have, for the most part, not engaged in industry-level organization or cooperation. While they briefly formed an association in the 1980s, it failed to generate significant momentum or result in significant benefits. In 2007, the IOs formed the Independent Forest Operators of Saskatchewan (IFOS), which was mandated with lobbying, and investigating and implementing strategies to increase profitability. While IFOS was able to develop strong relationships with government and initiate research projects related to IO issues, member interest and participation declined with the province's forest industry decline and the economic challenges that occurred beginning in 2008.

Since IFOS ceased activities in 2010, the economic climate has worsened. According to former IFOS president Perry Vermette, several IOs have exited the industry and many others have had reduced sales. As a result, many IOs have seen drastic reductions in the scale of their operations and are only marginally viable. Consequently, the IOs that have survived the economic downturn have recently expressed an interest in reforming the organization (Vermette, 2012).

1.1 IO Challenges

Due to scale, the IOs are characterized by above-industry average fibre procurement costs and transaction costs. In the past, IO's costs were not a problem because market prices were above average for their products and they faced limited competition within markets. In recent years however, forest product markets have become increasingly competitive, which has been confounded by low demand and low prices. Additionally, operating costs have risen faster than inflation because of higher fuel and energy costs. As such, the IOs have indicated a desire to restructure operations to reduce costs and increase competitiveness.

In addition to these challenges, IOs have weak tenure security and a lack of access to fibre, both of which are a result of the provincial forest tenure structure. The sections that follow discuss these challenges in greater detail and provide a basis for a solution-based approach to restructuring of Saskatchewan's IO industry.

1.1.1 Downturn in the Forest Products Economy

Over the past decade, the Government of Saskatchewan has commissioned a small body of research to identify the economic issues affecting Saskatchewan's forest industry and providing solutions to increase the competitiveness of Saskatchewan's forest products producers. The Premier's Task Force on Forest Sector Competitiveness Report (2006) identified a number of global factors contributing to the weakened economy including the declining value of the American dollar, weak lumber demand caused by the U.S. housing market crash, weakening paper markets, an unfair "softwood lumber deal", and increasing imports of low-cost foreign-wood products. The same report identified internal factors such as escalating transportation costs (including the removal of a fuel tax exemption) and road development costs as having an equally significant effect on forest industry firms' viability and competitiveness (Government of Saskatchewan, 2006.) These combined factors resulted in a situation in which IOs are faced with low demand, low prices, and increasingly competitive markets.

1.1.2 Economies of Scale

Given the IOs' relatively low allocation volumes in comparison to larger corporate entities (e.g. Domtar), it is intuitive that their small-scale operations have an above-industry-average cost structure and will be less competitive. Less intuitive, are the high transaction costs associated with IO fibre procurement. The planning and permitting processes that precede active forest harvesting require that information and negotiation costs be incurred by producers. In the case of permitting, the information and negotiation costs are fixed and do not vary among producers of different sizes. For example, a producer who harvests 500m^3 of timber invests the same amount of time and resources into the permitting, development and negotiation processes as does a producer who harvests 20,000m^3. Similarly, while there are some variations in the planning costs of these same producers, many of those costs are largely fixed (Vermette, 2009). This creates a situation in which IOs the transaction costs per cubic metre harvested are higher for IOs than for medium sized forest producers.

1.1.3 Tenure and Access to Fibre

Many IOs identify a lack of access to fibre as a major challenge which inhibits their ability to expand their businesses and generate significant economies of scale (Sande, 2009; Vermette, 2009). Unlike many other jurisdictions across Canada and the United States that use a large proportion of area-based tenure instruments, Saskatchewan's forest tenure is primarily granted through volume-based instruments that grant holders the right to harvest a predetermined amount of timber for a period of one to 20 years. The majority of the province's timber is held in the form of forest management agreements with terms of twenty years and term supply licences with terms of approximately ten years. At the current time, these instruments lack enforcement mechanisms that require tenure holder's to utilize their allocation volumes and as a result the province's resource is under harvested. Historically, a number of IOs attempted to increase their annual allocation to meet surges in demand and to plan for growth, however, were unsuccessful because the current tenure structure fully allocates timber to existing tenure holders indefinitely (Vermette, 2009). Currently, Saskatchewan does not use tenure instruments such as direct sale auctions that would allow producers to competitively bid for allocation volumes. The lack of opportunities for increased tenure volumes has resulted in a situation in which the growth potential of IOs is limited by fibre availability.

1.1.4 Fibre Utilization

All IO value added production processes share one common trait, they have high fibre specificity. IO products such as lumber, construction logs, and railway ties, for example, require large diameter logs exceeding six inches in diameter, while IO products such as fence posts and rails require small diameter longs under six inches in diameter. This is problematic as the trees harvested by IOs carry a significant taper and produce cut to length shortwood pieces that belong to both the over six inch and under six inch diameter classes. Given that IOs are generally producing a single product or range of products that require only fibre belonging to one of the diameter classes, a significant portion of fibre cannot be utilized by each IO's production processes. In the past, some IOs with larger allocation volumes were able to sell the fibre that could not be utilized by their production process to larger saw mills and pulp mills to recover a portion of their costs, however, the downturn in the forest sector has led to the closure of all but one of these facilities in the PAFMA. This, coupled with the absence of an established market for wood fibre in Saskatchewan has created a situation in which many IOs are unable to sell the wood that cannot be utilized in their production processes on a cost recovery or profitable basis. Instead, this fibre is often maintained in inventories until IO firms are in a position to write off the inventory or is sold at a heavily discounted rate to cover the in yard handling costs (Vermette, 2009; Sande, 2009). The net effect of this is an increase in the overall fibre costs for IOs. To date, there has been no organized attempt by IOs to engage in trading of wood fibre to overcome this challenge, despite the fact that the proportion of IOs (on a per cubic metre basis) requiring large diameter material is approximately equal to the proportion requiring small diameter material.

1.2 Purpose

I have hypothesized that the IOs might be able to achieve fibre procurement cost reductions through the formation of a fibre procurement cooperative. More specifically, the cooperative model has the potential to create economies of scope in IO fibre procurement and increase fibre utilization, and would allow for the elimination of the competitive inefficiencies that exist within the industry, thereby further reducing production costs. Through the development of cost models that depict the current IO fibre procurement scenario (factual case) and the proposed IO cooperative fibre procurement scenario (counter-factual case), this study will seek to use a comparative analysis of fibre procurement costs under the factual and counterfactual models to evaluate whether or not reorganizing the IOs' fibre procurement activities using a cooperative model is a viable option for reorganizing and revitalizing IOs in Saskatchewan's forest sector. If the proposed cooperative fibre procurement model proves to be cost reducing, the hypothesis that the formation of a cooperative will result in fibre procurement cost reductions and provide positive net economic benefits to producers will be deemed to be true.

1.3 Research Objectives

The primary objective of this research is to evaluate the possible economic benefits provided to IOs through reorganizing fibre procurement operations into a co-operative framework. In order to achieve these objectives, this study seeks to do the following:

1. Analyse the applicability and potential success of the cooperative model in forestry and relate that to the Saskatchewan IO case.
2. Develop a potential IO cooperative structure that focuses on reducing IO fibre procurement costs by creating economies of scope for IOs fibre procurement activities and increasing fibre utilization for IOs.
3. Develop a cost model depicting current IO fibre procurement costs and utilization (The Factual Model).
4. Develop a fibre procurement cost model depicting fibre procurement costs and utilization under the proposed IO Cooperative (The Counter-factual Model).
5. Obtain IO fibre procurement cost and utilization data using a case study methodology and utilize that data in the running of the factual and counter-factual fibre procurement cost models.
6. Conduct a comparative analysis of the results obtained from the derived factual and counter-factual fibre procurement cost models to determine whether or not the proposed cooperative model will provide economic benefits to the IOs in the form of cost reductions.

1.4 Thesis Overview

Chapter two presents the results of the literature review pertaining to the different types of forest producer cooperative models used in other jurisdictions. In chapter three, the reader is presented with a potential IO co-operative structure and a detailed account of the methodologies employed in the analysis. Chapter four begins with the presentation of the current IO fibre procurement process and the factual “business as usual” fibre procurement cost model. The second half of the chapter discusses the operational details associated with the proposed IO cooperative fibre procurement process and presents the IO cooperative fibre procurement cost model.

In chapter five, the results obtained by fitting the sample IO data into the factual and counterfactual fibre procurement cost models is presented and comparatively analyzed. The chapter closes with a discussion of the implications of the study and potential future research work related to the subject.

CHAPTER TWO: LITERATURE REVIEW

2.0 Introduction

This chapter presents the results of a literature review focused on the various types of cooperative models currently in use and their application in forestry. The chapter also presents insight into the current tenure structure that IOs within Saskatchewan operate within. Information obtained within this literature review is used in later chapters to derive a potential cooperative model for the proposed IO fibre procurement cooperative.

2.1 The Cooperative Model

In order to explore forestry cooperatives we must first understand the nature and structure of the general cooperative model. A cooperative can be broadly defined as a private organization that provides benefits and services to cooperative members, who are also the owners of the cooperative. The cooperative model has been used to address a wide variety of challenges in almost every sector of the economy (Gertler, 2004; Martin, 2007). Cooperatives play a significant role in Canada's national economy and provide a wide range of benefits to the local economies in which they operate. In 2004, cooperatives in sectors such as agriculture, finance, fisheries, forestry, health care, housing, manufacturing, and retail employed 85,073 Canadians and contributed $27.5 billion to Canada's GDP (McMartin, 2007).

In general, the membership of a cooperative consists of a group of individuals or firms with common needs and goals whom are located in close geographical proximity (Fulton and Gibbings, 2000; McMartin, 2007). In the cooperative model the members have equal control of the cooperative, but varying levels of ownership that are tied to the member's level of equity investment in the cooperative. This is counter to the majority of private corporations, in which ownership is held by the shareholders and control of the company is held by hired executives (Welch, 2001). The self-governance model employed in cooperatives is possible because cooperatives are democratically controlled by their membership through the one member, one vote system constructed by the Rochdale Society of Equitable Pioneers in 1844 (Fulton, 2000; Fulton and Herman, 2000; Haaf and Stefanson, 2001; Welch, 2001). In this system, cooperative members elect a board of directors and vote on major policies with equal influence. The board of directors is charged with managing the cooperatives' long term business affairs and in most cases the board of directors hires an operations manager who, in turn, is charged with managing day to day business operations (McMartin, 2007; Welch, 2001).

In Saskatchewan, cooperatives are required to incorporate at the time of their formation (Anonymous, 2009c) and thus become a distinct legal entity (Welch, 2001). This provides an advantage in that it allows the corporation to engage in any form of transaction that an individual person would be allowed to engage in. For example, a corporation may engage in contracts, purchase and own real estate, or become engaged in litigation proceedings. In addition, incorporation limits the legal liability of members to ensure that they do not become personally responsible for the corporation's legal or financial obligations. The major disadvantage of incorporating is the initial transaction costs associated with establishment.

The fundamental purpose of a cooperative is to provide increased benefits to its membership (Welch, 2001). The cooperative structure can achieve this in many different ways and the origin, type, and extent of benefits for the cooperative members depends heavily on the objectives of the cooperative. One of the most common benefits is the reduction in costs through the creation of economies of scale (Welch, 2001). Economies of scale are created when the fixed costs of providing a good or service to the members are spread over more units, thus reducing the average cost for a good or service. Economies of scale can also be created when members jointly purchase inputs and supplies and are able to purchase larger volumes from vendors and thus negotiate lower purchase prices. In some cases the reason for forming a cooperative is not due to a need for cost reductions but rather a need for revenue stabilization. This is generally the case when there is market failure and producers face low prices. In this case the formation of a cooperative often results in a situation in which producers are able to work together to ensure that they obtain higher prices (Welch, 2001). In both cases, the members are able to gain increased market power through cooperation.

Cooperatives are also formed to ensure that producers, consumers, workers, or even entire communities are able to access goods and services (Welch, 2001). In some cases the goods or services do not exist or are unavailable because neither the private sector nor the government is willing to provide them. In other cases the private firm or government agency that provided the goods has ceased to exist or moved out of the region. Whatever the case, the cooperative model is often used to provide goods and services that are absent or in jeopardy of being lost to their membership. The cooperative model also provides members with the ability to pool their assets and increase their ability to procure financing for larger projects and capital equipment including new technologies. The joint investment in these ventures also allows the cooperative members to pool the risk of investing. This reduces the expected loss for each member (Welch, 2001). In this way, risk pooling through cooperative formation can provide additional incentive to make larger investments. This not only increases the opportunities for the individual members but it also increases the opportunities for overall community economic development (Welch, 2001).

Another method by which cooperatives generate benefits for their members is through the reduction in transaction costs. Transaction costs are generally classified as negotiation costs, information costs, or enforcement costs. Negotiation costs are those costs that are incurred in the formation of an enterprise, the negotiation of contracts, and the negotiation of prices (Hobbs and Kerr, 1999). Negotiation costs generally include such things as fees charged by lawyers, accountants, and other professionals. Information costs are the costs incurred by searching for and organizing information that is essential to the operation of an enterprise. Enforcement costs consist of all costs associated with ensuring that contracts are honoured and action is taken when they are not (Hobbs and Kerr, 1999). Enforcement costs may vary from protecting property from theft, to ensuring that a customer pays, to litigating a supplier that has defaulted on a supply contract. Cooperatives are often able to reduce these costs by ensuring that members have access to professionals who can help them to create more efficient contracts at a reasonable price (Fulton and Sanderson, 2002). Transaction costs might also be reduced through the creation of economies of scale when cooperatives engage in transactions that involve much larger quantities. By negotiating a single contract for the entire cooperative, repetition of transactions is eliminated and fixed costs are spread over many more units. The effect of this is a reduction in average transaction costs, increased profit margins, and thus an increased ability to remain competitive.

Not all of the benefits that cooperatives provide are economic in nature. Many cooperatives provide education to their membership in the form of workshops, training, field days, and publications (Welch, 2001). Members benefit from gaining more knowledge of the industries in which they operate and the operational activities of the cooperative. In many ways, the communities in which the cooperatives operate also benefit from the cooperatives' various activities. Often times cooperatives provide jobs that would otherwise be absent and as such they increase community employment rates and ensure greater local economic health.

Furthermore, because most cooperatives are owned by local people, much of the revenue generated stays within the community and further fuels economic development (Welch, 2001). The local nature of the cooperative's ownership creates a situation in which cooperatives are often more committed to the community than private corporations with foreign ownership and, as such, many cooperatives have an increased focus on sustainable community economic development (Welch, 2001; [5]White, 2008).

2.2 Success of the Cooperative Model

Cooperatives typically enjoy significantly higher success rates than private corporations, with 46% of cooperatives surviving their first ten years and only 20% of private sector companies making it to the ten-year mark (Bond, Clement, Cournoyer, and Dupont, 2000). In general, cooperatives that form as a result of market failures are much more successful than those that are formed to address oversupply in the market (Fulton and Gibbings, 2000). Several studies have identified critical factors that contribute to the success of cooperatives. Welch (2001) identified seven different success factors that can greatly increase a coop's chance of survival. The first of these is to ensure that both inside and outside expertise is used effectively. It is not only essential that coops trust and use the experience of people within the organization, but also that they seek the professional experience of external consultants. This is especially important during the planning and development phase when the fundamental research into the feasibility of the cooperative is occurring (Welch, 2001). The feasibility study and business plan form the two most essential documents of the fledgling cooperative. These documents are the first step in determining whether or not a cooperative has the potential to succeed and the issues it might face as it moves forward.

Welch's second key to success is to keep the cooperative's members informed and involved. Failure to do so results in a situation in which members feel a lack of control and simply become resentful or disinterested in the process and this can lead to the break-up of the cooperative (Fulton and Gibbings 2000; Welch, 2001). This is linked to group cohesion, which Welch identified as another critical success factor. If the coop's membership does not understand the goals of the cooperative it becomes difficult to remain committed to and involved in the cooperative. The maintenance of a strong relationship between the board and management is also important as nothing can be accomplished if these two entities are not cooperating and working together to achieve the same goals (Welch, 2001).

Welch also identified the conduction of professionally structured meetings as another important factor in the success of a cooperative. By conducting professionally structured meetings the group can remain more productive and will take the entire process a lot more seriously. Similarly, operating the business in a professional manner and following proper business practices is essential, particularly when dealing with the financial aspects of the coop. Failure to do this will only decrease the faith of the membership and prospective financiers of the cooperative. Lastly, Welch highlights the importance of linking with other cooperatives throughout the life of the cooperative. By drawing on the experiences of groups that have already been through the cooperative development process, new cooperatives can greatly decrease the chances of making common mistakes and reduce their information costs (Welch, 2001; White, 2008d).

Travers (2004) credits the success of the cooperative model to its unique ability to consolidate the experience, knowledge, and views of a large number of people. By harnessing the knowledge, skills and experience of a number of individuals the cooperative is stronger than a comparable private firm (Travers, 2004; Welch, 2001). Fulton and Gibbings (2000) attribute the success of cooperatives to the strength of the cooperative's relationships. The three key relationships that Fulton and Gibbings identify are the relationships among members, the relationships among the activities the coop undertakes, and the relationship between members and the coop's activities. They go on to state that the strongest relationships are those with the highest degrees of integration where the activities and elements in a relationship are highly connected and interdependent. Generally cooperatives with the highest degree of integration have the largest number of complementarities. The fact that a cooperative's strength is determined by the strength of its relationships highlights the importance of governance and effective management (Fulton and Gibbings, 2000).

Member commitment is another important factor that Fulton and Gibbings address, which Welch identifies as group cohesion. Tied to member commitment or group cohesion is member education. Successful cooperatives provide their members with educational opportunities pertaining to the industry in which the cooperative operates and the activities of the cooperative. By providing members with education, cooperative organizers can ensure that members maintain their connection with the cooperative and continue to have common goals (Fulton and Gibbings, 2000).

2.3 Common Sources of Cooperative Failure

Typically, cooperatives that fail were doomed from the start. Cooperatives are often formed in response to rapid economic change and crisis (Fulton and Stefanson, 1997; Gertler, 2004). This causes cooperative organizers to rush through the development in hopes of finding a quick fix to the problems that they are facing. As a result they often neglect to achieve or consider one or more of the factors that are crucial to their success. Perhaps the most common pitfall is a lack of appropriate planning (Welch, 2001). The development of feasibility studies and business plans involve a substantial amount of research, which in turn involves a significant time investment. High quality, well-researched feasibility studies and business plans are priceless as they are the cooperatives' first line of defence in identifying potential problems that lead to failure. When cooperative organizers rush through the development process and cut corners on research into the feasibility of the project the risk of all involved losing their investment is greatly increased. In addition, when the financial research that is usually conducted in the feasibility study and business plan is neglected, it is highly likely that the cooperative will have financing problems (Welch, 2001).

Furthermore, the lack of a well-designed business plan can create a situation in which the cooperative lacks direction and organization. This can result in the cooperative wasting a large amount of time and initial operating capital trying to figure out where it is going and what it is doing. In addition, the absence of a well-developed business plan that members support and understand can create a situation in which each member has their own idea of where the cooperative is going (Welch, 2001). Without a predetermined set of commonly agreed upon goals the members cannot even begin to cooperate and work together for the betterment of the cooperative (Fulton and Gibbings, 2000; Welch, 2001).

Another common problem that cooperatives face is a lack of effective leadership. This applies to both leadership within the cooperative's management and the cooperative's membership (Fulton and Gibbings, 2000; Welch, 2001). Poor financial management can eventually lead to bankruptcy and poor operational management can result in failure to meet production targets and business commitments. Ineffective relationship management can cause deterioration of business relationships and lead to conflicts between management and the board of directors. All of these issues have the potential to greatly inhibit the cooperative's ability to function and succeed. Ineffective leadership, including that of the board of directors, can also represent a significant handicap for cooperatives; this is especially true as the cooperative ages resulting in a tendency for increasing heterogeneity in both the composition and goals of the cooperative's membership (Fulton and Gibbings, 2000). Managers that cannot effectively mobilize members and facilitate constructive communication within the membership make it increasingly difficult for the cooperative to meet the needs of the membership (Fulton and Gibbings, 2000; Welch, 2001). When this occurs, members who begin to feel isolated and become disenchanted with the cooperative and the value that it provides to them. As a result many of these members begin leaving, and if left unchecked, can lead to a complete breakdown of the cooperative.

The fact that the value of the cooperative's membership shares are not tied to the level of equity within the cooperative presents another interesting problem for companies employing the cooperative model. In a private firm, shareholders' shares have a value that is based on the assets and financial success of the cooperative. As such, when shareholders wish to exit the organization they are able to recoup their initial investment and any appreciation in the share value by selling them. This is not the case in the general cooperative model as the cooperative owns the assets and member shares do not entitle the holder to a portion of those assets; member shares have no significant value and members are not able to recoup the appreciation in value their equity investment provides to the cooperative. This presents a problem for older cooperatives with an aging membership as members who know they will be exiting the cooperative soon and will no longer enjoy the benefits it provides have little incentive to make equity investments in the firm. This can make it difficult for the cooperative to expand or replace aging capital without attracting new younger members.

2.4 Relevant Cooperative Types

2.4.1 Forestry Cooperatives

Forestry cooperatives can be broadly defined as any business that operates in the forestry sector and employs the basic principles and structure of the cooperative model (White, 2008c). Existing and previously existing forestry cooperatives have engaged in a variety of forestry related activities including forest management, fibre harvesting, forest product production, forest product marketing, and sustainability certification (Gertler, 2004; Karg, 2000; White, 2008c). Membership of forestry cooperatives ranges from producers to workers to entire forestry-dependent communities (White, 2008c). The objectives of the various types of forestry cooperatives reflect the goals and views of the cooperative's members. The four main groups of forestry cooperatives are worker-owned, community-owned, woodlot/private landowner, and producer-owned. All of these cooperative models provide members and their communities with the same basic benefits provided by the cooperative model; but in addition, each of them offers a subset of benefits that are unique from the others. While there are advantages of each of the four classes of forestry cooperatives, I will focus on the producer cooperative given its applicability to the independent operators in Saskatchewan.

2.4.2 Producer Cooperatives

Producer-owned cooperatives are formed by individuals and companies that produce similar commodities and products to provide economic benefits (MacPherson, 2003). Although there are some producer cooperatives operating in the forestry sector, the majority of producer cooperatives operate in the agricultural sector. While the two sectors are different, there are enough similarities to warrant investigation.

The first, and most obvious similarity exists in the type of products and markets that forest products and agricultural products are sold in. Both sectors produce commodities that are heavily exported into a competitive global marketplace that demands lower prices and stronger product differentiation. Second, both sectors have producers with production volumes that vary from the large production volumes of large corporately owned and integrated farms and lumber mills to the substantially lower production volumes of small family farms and small independent saw mills. Smaller producers in agriculture and forestry face the problems of comparatively higher cost structures and the lack of access to professional services and technology that are associated with a lack of economies of scale, thus making it increasingly difficult for them to compete in a global marketplace. Last, both industries require capital equipment, diesel fuel, labour, and large levels of operating capital to bridge the gap between investment in inputs and the receipt of revenues from finished products. Next, I will explore three types of organization: supply, marketing and new generation cooperatives.

2.4.3 Supply Cooperatives

The function of a supply cooperative is strictly to provide economic benefits to its members through the creation of economies of scale in the purchasing of necessary goods and services. The economies of scale are created through joint purchasing of a large volume of homogenous goods that all of the members require. This gives the cooperative volume buying power and allows them to negotiate lower prices (MacPherson, 2003; White, 2008e). The benefits that accrue as a result of the cooperative's volume buying power are conferred to the members in the form of lower prices at the point of purchase or through the issuance of dividends at yearend. The membership usually consists of a group of producers who are operating in the same industry and producing similar products using similar inputs; this is essential in ensuring that the group achieves optimal purchasing power for all of the goods they provide to their members and that the cooperative has a common objective. Supply cooperatives follow the traditional cooperative model in terms of employing the one-member one-vote system, as well as a member-elected board of directors. In most cases, they will hire a cooperative manager and any additional employees who might be required to negotiate prices with vendors and complete sales contracts.

Supply cooperatives are most common in agriculture where supply cooperatives play an important role in providing small-scale agriculture operations with access to lower-priced farm inputs such as fuel, fertilizer, feed, and seed (Macpherson, 2003; McMartin, 2007). In 2004, there were 219 supply cooperatives operating in Canada, which collectively generated total revenues of $4.4 billion of which $1.98 billion (45%) was generated from the sale of farm petroleum, $1.01 billion (23%) was generated from the sale of fertilizer, $620 million (14%) was generated from the sale of feed, and the remaining $790 million (18%) was generated from the sale of other farm inputs (McMartin, 2007). An example of a successful agriculture supply cooperative in Saskatchewan is Federated Cooperatives Ltd., which operates agriculture supply stores in a number of Saskatchewan cities and towns. In this cooperative, the benefits of volume purchasing are distributed to members through the issuance of patronage dividends that are positively correlated to the total dollar value of the member's purchases.

There were no examples of forestry cooperatives that could be classified strictly as a supply cooperative. Instead it seems that the functions of a supply cooperative are integrated as a secondary function into the mandate of other types of forestry cooperatives. Examples of this include the Athol Cooperative retail store, which provides forestry-related supplies to the members of the Athol cooperative. In this example, the volume buying benefits of the aggregated forestry supply purchases are distributed to Athol's members through lower prices at the point of purchase (Anonymous, 2009a; Anonymous, 2009b).

2.4.4 Marketing Cooperatives

The role of a marketing cooperative is to market the products produced by its members into existing markets and also to develop new markets (MacPherson, 2003). Usually the marketing cooperative is responsible for the sale and pricing of cooperative members' entire production volumes. By aggregating production into a larger marketable volume, the marketing cooperative is able to create economies of scale. For example, a timber marketing office could market 40,000 cubic metres of fibre just as easily as it could market 10,000 cubic metres of fibre without incurring additional costs. Furthermore, the collective marketing of a substantially larger volume could provide producers with increased market power and allow for the negotiation of higher sales prices (MacPherson, 2003). By entrusting the marketing of products to professionals hired by the cooperative, producers are able to place more focus on production and the operational aspects of their businesses.

Agricultural marketing co-operatives are among the most successful of the producer cooperatives operating in Canada (McMartin, 2007). In 2004, Canada's agricultural marketing cooperatives generated $7.7 billion in revenues. The most notable agricultural marketing cooperatives in western Canada were the Saskatchewan Wheat Pool, which marketed grain and oilseed for Saskatchewan's grain farmers, and Lilydale, which processes and markets poultry products for Saskatchewan's poultry producers (Fulton and Herman, 2001; MacPherson, 2003; McMartin, 2007). There were no revenue data for Canadian forestry marketing cooperatives, likely because most are integrated with other types of forestry cooperatives. Examples of forestry cooperatives that have integrated marketing functions into their businesses are the Koocanusa Value Added Cooperative, the Athol Forestry Cooperative and Upper Canada Woods Cooperative (Anonymous, 2007a; Anonymous, 2009b; Anonymous, 2008a; Kinnis and Smith, 2003).

2.4.5 New Generation Cooperatives

The new generation cooperative (NGC) model is the most recent cooperative model to emerge and includes one example in the forest sector: the Kookanusa Value Added Cooperative (KVAC). The basic goal of an NGC is to provide value-added processing and to market such products. By adding value to inputs that might otherwise be sold into commodity markets, the NGC is able to extract an additional level of profit (Gillis, 2008; Haaf and Stefanson, 2001; MacPherson, 2003; Welch, 2001). Profits in turn, are redistributed to producers in the form of patronage dividends (Gillis, 2008; Kinnis and Smith, 2003). In many cases, NGCs add value to products through additional capital and technology to further differentiate products. In other cases, NGC's provide members with access to new capital and technology to create new products (Gillis, 2008). In almost all cases the producers would not have been able to independently access technology or capital because they lacked sufficient production volumes to warrant the large capital investment or because they would not have been able to secure the required financing. The formation of a new generation cooperative can solve these problems by pooling resources and creating economies of scale that make large investments feasible. Pooling resources also allows NGCs to better access financing as banks are often more likely to lend to a cooperative than an independent rural producer (Kinnis and Smith, 2003).

In addition to ensuring that members receive equitable returns on pooled resources, the NGC's unique share structure can also provide additional opportunities for the procurement of finances for capital investment. There are three share classes in the typical NGC model. Membership shares are similar to those in all other cooperative models in that those possessing membership shares are given the right to vote in board elections and cooperative decisions. NGCs operate under the one-member one-vote system and there is no ability for larger producers within the membership to exert control. In the NGC model, membership shares also provide the shareholder with the right to purchase equity shares, also known as delivery shares (Fulton and Stefanson, 2007; Haaf and Stefanson, 2001). Equity shares or delivery shares are used as a means of generating start-up capital for the cooperative and as a method of assigning commodity delivery rights to the producers. One equity (delivery) share provides the shareholder with the right to deliver one unit of a commodity input to the NGC (i.e. one bushel of wheat, one cubic metre of pulp wood, etc.). Delivery rights carry with them the obligation for shareholders to deliver to the cooperative the exact quantity and quality of the commodity for which they hold delivery rights. This ensures that the cooperative will always have a sufficient quality and quantity of inputs to meet production targets. Similarly, the cooperative has an obligation to accept and pay for the exact quantity of a commodity for which a shareholder possesses delivery rights (Fulton and Stefanson, 2007; Haaf and Stefanson, 2001; Kinnis and Smith, 2003). This provides added security for producers and ensures that they will always be able to reap the benefits of their equity investment. Membership shares, and thus equity shares, are only provided to producers to ensure that producers maintain control of the cooperative and to ensure that only product belonging to the producer members is used by the NGC. Producers who hold equity shares are generally able to transfer or sell their shares, with approval of the board of directors, to existing equity shareholders or individuals who purchase the assets of the shareholder (Haaf and Stefanson, 2001). This ensures that equity shares possess a value and that shareholders can recover their equity investment when they choose to exit the industry or to leave the cooperative.

The equity share system used by the NGCs has proven to be successful at generating substantial levels of start-up capital. At the same time, the system provides members with security and a guaranteed return on their investment. When the North American Bison Cooperative was incorporated it initially sold 180 US$100 membership shares to members who then purchased a minimum of ten US$250 equity shares each. As a result the cooperative was able to generate enough cash flow to cover almost 50% of their start-up costs. Since NGCs are often able to generate such a large level of initial cash flow through the sale of equity (delivery) shares, they often have much lower initial debt loads than companies in comparable industries that use one of the other cooperative models (Haaf and Stefanson, 2001). In addition, the increased level of investment by members can induce member commitment to be stronger than for other cooperative models; this can result in a higher success rate as member commitment has been identified as one of the keys to a cooperative's success (Fulton and Gibbings, 2000; Fulton and Stefanson, 2007; Haaf and Stefanson, 2001; Welch, 2001). In addition to equity shares, NGCs also use preferred shares as a means of generating sufficient start up and operating capital. Preferred shares allow the cooperative to generate additional capital investment from both producers and non-producers. Preferred shareholders hold no voting rights or delivery rights and generally offer a fixed rate of return on their investment. In many cases preferred shares are sold to community development organizations and other parties who have an interest in supporting the community and economic development that NGCs can provide (Haaf and Stefanson, 2001).

Banks or other financial lenders who have provided loans to the cooperative may also hold preferred shares as a means of ensuring legal security to the cooperative's assets during the term of the loan.

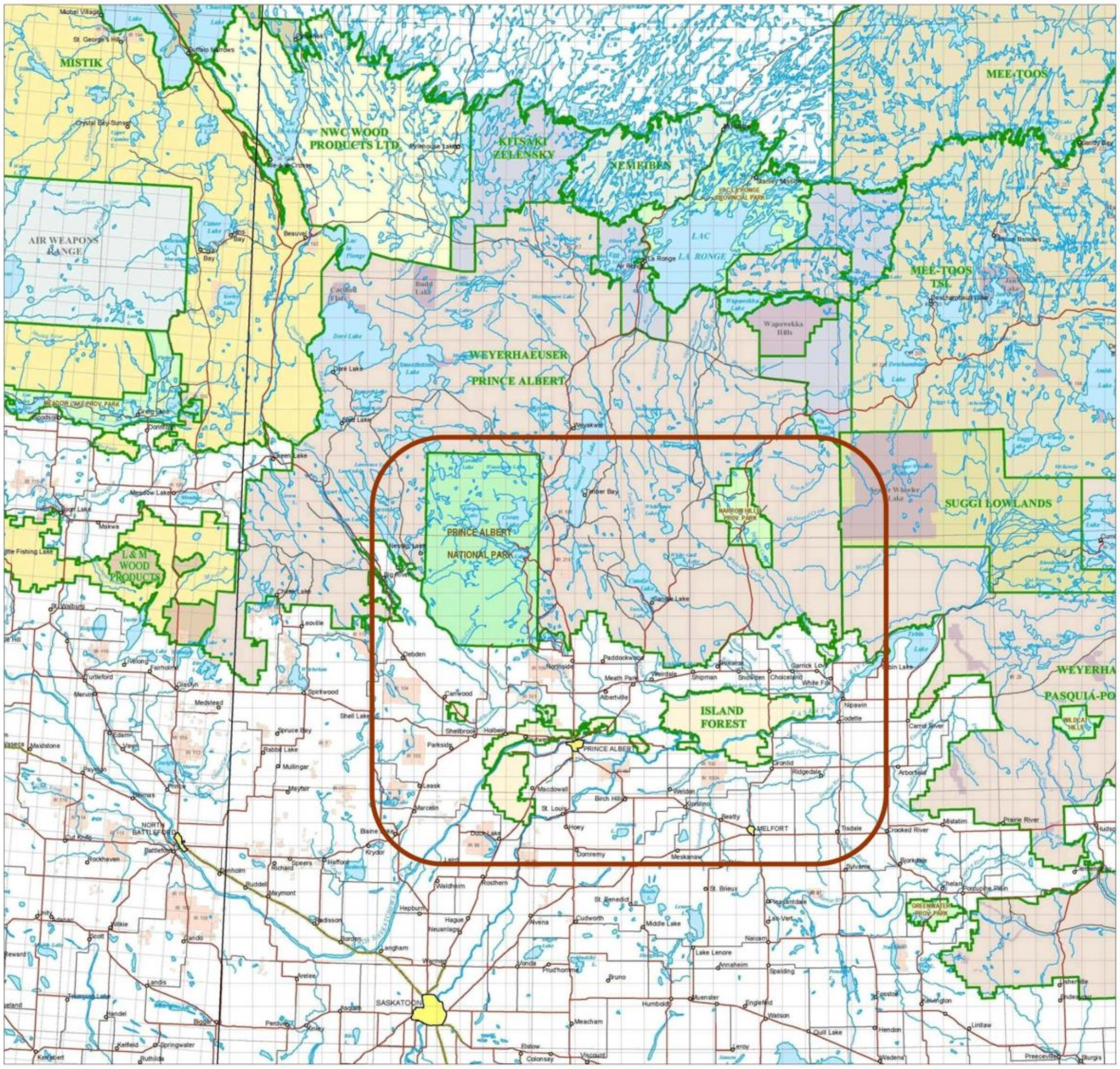
2.6 Forest Tenure in Saskatchewan

There are three types of forest tenure instruments that are currently employed in Saskatchewan: Forest Management Agreements (FMAs), Term Supply Licences (TSLs), and Forest Product Permits (FPPs).

FMAs are 20 year tenure agreements formed between the provincial government and large forest producers that operate large pulp and paper mills or sawmill within the Province. In addition, to providing the longest forest tenure duration available in the province, they also provide firms with the greatest degree of fibre supply security. FMAs provide the agreement holder with long-term harvesting rights throughout a certain tract of land contained within the borders of the FMA. These agreements have the advantage of providing the longest tenure duration available to forest producers but carry onerous and often expensive forest planning and management costs. There are currently five FMAs in Saskatchewan's commercial forest area. The IOs within this study operate in the Prince Albert Forest Management Agreement area (PAFMA) and the Island Forest Management Agreement Area. The geographical area encompassed by the FMAs is shown in Figure 2.1. All IO mills related to this study are contained within the red border in Figure 2.1.

TSLs are medium range tenure instruments that cover periods of five to ten years and provide firms with an intermediate level of fibre security. TSLs provide their holder with the right to harvest a specified quantity of timber annually from a pre-defined geographical area. These tenure instruments allow producers to hold tenure over a longer period of time than Forest Product Permits and carry less onerous forest management and planning obligations than FMAs. Historically, TSLs were typically granted to firms with medium to large fibre allocations that operated sawmills throughout the province. In northern areas of the province TSLs have been assigned to areas not covered by an FMA but in the more southerly portions of the commercial forest TSLs are often granted within the boundaries of an existing FMA. More recently, the government has made TSLs available to IOs with relatively small allocations whom, in the past, would only have been granted annual Forest Product Permits.

Figure 2.1: Saskatchewan FMA Map



Source: Government of Saskatchewan, 2013.

Despite this, most IOs continue to be granted their allocations through Forest Product Permits (FPPs). These tenure instruments have an extremely short duration, granting their holder an allocation within a specific FMA for a period of one year. FPPs also confer their holder with the least degree of legal security to the timber supply, as technically, the government could simply choose not to renew them upon application. For the most part, this does not happen and the crown and IOs operate under a gentleman's agreement promising annual renewal in perpetuity. In addition to having the lowest level of tenure security, FPPs are also the most inflexible form of tenure available in Saskatchewan's forest management system. Generally, FPPs require that their holder file an annual operating plan that targets specific timber blocks within a predefined operating area. The chosen timber blocks within the plan contain a volume of timber which equates to the annual allowable cut of IOs. For IOs, these volumes range from approximately 500 m^3 to 20,000 m^3.

It is important to note that in each FMA there are a large number of FPP and TSL holders, of whom the majority are IOs, that are granted timber harvesting rights across the large geographical area encompassed by the FMA. The FPP and TSL holders operating within FMAs are not assigned to specific timber stands or areas within the FMA but are instead able to target stands throughout the entire FMA. This creates a situation in which IOs have overlapping fibre procurement activities and this has driven competition among IOs.

2.5 Conclusions

There are several examples of forestry cooperatives that have been successful in creating both economic and non-economic benefits for their members. The literature on agricultural producer cooperatives provides many examples of groups with characteristics similar to the IOs. Although none of the cooperatives identified provided producers with the same mix of services as those required by the IOs, the literature did provide insight into how the NGC model could be used to provide sufficient flexibility and to meet the unique needs of IOs. While the model's application in the forest sector has been rather limited, the structural and operational flexibility inherent in the NGC model and its history of successful application in the agricultural sector provide a strong basis for its use in the reorganization of Saskatchewan's IOs.

The current tenure regime in Saskatchewan provides IOs with a rather low level of tenure security. Moreover, the current system does not provide IOs with any degree of exclusivity in their harvesting rights. This has led to IOs overlapping forest procurement activities and competing with one another instead of coordinating their activities and benefiting from economies of scope. The cooperative model has the potential to resolve some of the inefficiency created by the current tenure regime through the coordination of fibre procurement activities and reduction of competition among IOs.

CHAPTER THREE: METHODS

3.0 Introduction

A qualitative approach was used to gather background information pertaining to IOs and their economic challenges. During October of 2009, personal interviews were conducted with the executive director of the Independent Forest Operators of Saskatchewan and the president of the Independent Operators of Saskatchewan. An open interview style was used to ensure that all details were captured. Information obtained from those interviews was then used to develop a listing of the major challenges that the IOs face and subsequently, to frame the problem. A follow-up interview was conducted with the president of the IOs in the fall of 2012 to validate information obtained from the first interview and to track changes.

To address the challenges IOs are facing, the adopted IO cooperative model must be able to: (i) increase competitiveness, (ii) increase access to fibre, and (iii) increase access to capital including human capital such as forestry professionals. This chapter begins with a detailed discussion of the share and organizational structure that could be employed by the IO cooperative. Additionally, I used economic analysis and a case study approach to compare economies of scope under two operating frameworks – business as usual using the financial information gathered during the interviews, and the proposed NGC framework. Details of the approach are included below.

3.1 Analytical Methodology

A comparative economic analysis was used to compare total fibre procurement costs of the business as usual case and the NGC case. The comparative economic analysis was chosen for its efficiency and ability to clearly illustrate variations in potential net economic benefits under both scenarios. Given that this study is focused on determining whether the cooperative model can generate economic benefits, the proposed cooperative's primary function as a raw wood supplier, and the high contribution margin of fibre procurement cost to the IO's overall cost structure, it was determined that fibre procurement costs would be compared. More specifically, since it has been proposed that restructuring the IOs under an NGC model might create economies of scope, the comparative analysis focuses on average fibre procurement costs.

The average fibre procurement cost function is derived by dividing each of the fibre processing cost functions by Q_j, where Q_j is the quantity of fibre processed. For the purposes of this study, it can be assumed that the same quantity of fibre is processed in all of the activities that make up the fibre procurement process. As such, average costs can also be obtained by dividing total fibre procurement costs by Q_j. Economies of scope are deemed to be present when the average cost of production decreases as the quantity of multiple outputs increase (Pindyck and Rubinfeld, 2004). As such, if average fibre procurement costs are shown to be lower in the counterfactual model than those seen in the factual model, economies of scope are present.

3.2 Case Study Methodology

In order to compare total fibre procurements costs and the resulting average fibre procurement costs, a significant amount of highly-detailed quantitative and qualitative data is required. Given the limited availability of data, it was determined that employing a case study methodology to gather data from the IOs themselves would provide the detailed qualitative and quantitative data necessary to conduct a comparative economic analysis.

The case study methodology has been widely used in the social sciences since the early 1900s (Tellis, 1997; Johansson, 2003). The methodology is most useful when a comprehensive, multi-faceted investigation is required (Feagin et al. 1991). The methodology's usefulness stems from the fact that it incorporates a number of research methods with the aim of triangulating detailed case data (Johansson, 2003). Case studies often focus on an individual, single organization, or group and are designed to elicit highly detailed information pertaining to the participant; this is accomplished through the use of multiple sources of data or evidence (Tellis, 1997).

3.3 Case Study Development

Following the steps identified in Soy (1997), development of the IO case study began with identification of qualitative and quantitative research questions. The questions identified under this step were as follows:

1. What are the steps involved in the fibre procurement process?
2. What are the labour, capital, and raw input requirements associated with each of the steps?

3. What are the costs associated with the required labour, capital, and raw inputs?

While the first question is largely qualitative, the second question has both quantitative and qualitative elements. The third question is almost purely quantitative in nature.

Direct observation of fibre procurement activities at the selected IO mill site ensured that the full scope of fibre procurement activities was obtained. Further detail regarding fibre activities was obtained through the review of procedural manuals and company documentation specific to the fibre procurement process. Last, archived production and financial records were used to verify financial and productivity data.

The final step was the development of the selection criteria that was used to select IO mills on which the case study would be based. It was decided that when choosing the IO firms, preference would be given to IO firms that were: intermediate in size relative to all other IOs, situated in a geographical location central to all other IO mills, willing to disclose three years of financial data, willing to have detailed discussions regarding operational processes, and had raw wood fibre size requirements that were intermediate to the size requirements of all other IOs.

It is important to note that the data analyzed within were limited to costs, effectively ignoring output price in the analysis. The justification for this is two-fold. Given the small size of IOs and the fact that many are producing similar products, for which there are in many cases substitutes, into similar, developed, competitive markets, it is reasonable to assume that the firms have little influence over prices and are price takers. In addition, given that the current proposed cooperative structure will not introduce cooperative marketing or output pricing elements, it is also reasonable to assume that the formation of the IO NGC will not have any effect on the producer's position as price takers. Consequently, while over the long-term output prices have effects on the viability of individual firms belonging to the cooperative, they will have no direct effect on the operational costs of the cooperative and thus, the feasibility of such a venture.

3.4 Independent Operator Data

A total of six IOs producing a variety of products with varying fibre needs expressed a willingness to participate in the study and to provide financial and operational data. A listing of the required financial and operational data was distributed to six participants, of which, one replied. Potential participants that did not respond were contacted a second time and, once again, no response was received. The IO that responded, Vermette Wood Products Ltd, was measured against the primary selection criteria developed for this case study. All of the required criteria were satisfied in full. First, the company is a medium sized IO firm operating a fence post mill near Spruce Home, SK in the rural municipality of Buckland (an area central to the geographic location of other IO mills). The company produces fence posts in a variety of sizes and utilizes medium sized wood fibre in their production process. In addition to satisfying these criteria, Vermette Wood Products was willing to provide all the required case evidence including documentation, historical financial and production records, interviews, and direct observation.

Data obtained from the interviews and direct observations revealed that the fibre procurement process employed by Vermette Wood Products Ltd., and all other IOs, has five distinct steps: forest management and planning, licencing, harvesting, scaling, and hauling (Klyne, 2009; Vermette, 2009). Within each of these steps there are a number of cost generating activities that occur. Forest management and planning involves all aspects of pre-harvest planning including: forest inventory analysis, harvest block/stand selection, and harvest planning and mapping. The licencing process includes activities related to forest licencing and permitting, and transportation licencing and permitting. The harvesting process is rather simple and relies on contracted loggers who harvest the stand as per the company's harvest plan and product specifications. These same contractors are generally contracted to conduct the in-block road building activities necessary to access timber. Once harvesting is complete, a scaling contractor is hired to scale the harvested timber and assess the crown dues and fees owing to the government. After the mandatory waiting period has passed, scaled timber is hauled to the mill site by the harvesting contractor. In the case of Vermette Wood Products Ltd., harvested timber is delivered in predetermined lengths of six to twelve feet. At the point of delivery, timber is deemed ready for value added processing and the fibre procurement process is complete (Vermette, 2009).

The quantitative data that was received from Vermette Wood Products Ltd. covered a three-year period. It consisted of complete financial and operational data for the years requested as well as continued access to detailed digital data including the corporation's general ledger and provincial wood-flow reporting databases. The high data quality allowed for a greater degree of detail in the development of the model and should, by effect, increase the accuracy of the model results. The data obtained through the case study are directly employed in the estimation of fibre procurement costs. The use of single source data in the estimation of IO fibre procurement costs has been deemed acceptable given that it is unlikely that any IO has production volumes that would allow for any degree of market power. Moreover, they operate in the same geographical market area increasing the likelihood that they face identical input prices.

CHAPTER FOUR: MODEL DEVELOPMENT

4.0 Introduction

This chapter focuses on the development of the fibre procurement cost models. The results of the case study and the description of the fibre procurement process are used to construct a cost model for the factual case in which IOs procure fibre independently. Next, the results of the case study, literature review, interviews with IFOS members, and interviews with Ontario IOs are used to create a detailed operational framework for the IO NGC. Finally, the counterfactual fibre cost model is developed based on the IO NGC operational framework and the NGC structure presented in Chapter Two. The two models are then compared in chapter five.

4.1 Business as Usual

Currently, IOs engage in a minimal level of cooperation. The small amount of cooperation that occurs is generally limited to involvement in the Independent Forest Operators of Saskatchewan, the lobbying group that represents the concerns of IOs in dealings with larger industry operators and government. In reality, most IOs do not compete in output markets, but instead sell their products into specialized, niche, or distant markets where their primary competitors are from western Canada and the United States (Vermette, 2009). Furthermore, while IOs share the same input markets, the volume of inputs demanded is relatively low and competition for inputs is weak.

For the most part, IOs follow the same basic fibre procurement process and face the same fibre procurement cost structure. The first step for IOs is to find an adequate quantity and quality of required wood within the prescribed forest management area. The associated costs are called "forest inventory costs." Where larger firms traditionally use professional services, the have low allocation volumes that do not allow them to regularly employ such individuals. Instead, IOs often rely on internal experience.

Once timber is selected for harvest, each IO must prepare harvesting and scaling plans that are then reviewed and accepted by the province's Ministry of Environment. During the review process, the IO and a provincial forester meet to discuss the plans in greater detail and to negotiate conditions associated with plan approvals. Upon approval of the harvesting and scaling plans, IOs apply to the Saskatchewan Ministry of Highways and Transportation for log hauling permits, overweight permits, and partnership whereby they are generally required to pay a per tonne highway tax for all fibre being hauled on provincial roads. These permits are negotiated for each IO on an individual basis and the Ministry of Highways and Transportation staff.

The next step is timber harvesting. While some IOs conduct their own small scale harvesting operations, the majority of the IO timber allocation is harvested by logging contractors. Often, IOs experience difficulties securing long term contractors given their relatively small individual harvest volumes that result in higher mobilization costs (on a per unit basis) than the higher volume contracts offered by larger mills. IOs who harvest their own timber are equally disadvantaged as a result of the high capital costs associated with harvesting equipment and their relatively small allocation volumes.

Once fibre is harvested it is measured and the amount of crown dues and reforestation fees owed for that volume are assessed (a process known as scaling). After timber is scaled it is hauled via semi-trailers to the respective IO mill where it is processed. At this point, the fibre procurement process is complete.

In order to develop a model that can be applied to all IOs, it is important to make general assumptions about economic, behavioural, and operational characteristics:

1. IOs are price takers and hold no market power.
2. Firms are profit maximizing.
3. Firms are rational.
4. Inflation is assumed at 2% per annum.
5. All IO's harvest locations are located at an equal distance from their primary mill site.
6. The absence of sufficient residual volumes does not allow for the sale of individual IO residual fibre to existing pulp and hog fuel markets.
7. Residual fibre cost recovery is not possible for IO mills in the current situation.

4.2 The Factual Fibre Procurement Cost Model

Nine cost components were identified in the fibre procurement process including that for: forest inventory, dues and fees, forest licencing, transportation licencing, harvesting, scaling, highway taxes, road building, and administration. Total fibre procurement costs are expressed as the summation of all costs (shown in equation 4.1).

$$TC_f = C_i + C_d + C_l + C_t + C_h + C_s + C_x + C_r + C_a \tag{4.1}$$

Where total costs are composed of,

C_i = Forest Inventory

C_d = Dues and Fees

C_l = Forest Licencing

C_t = Transportation Licencing

C_h = Harvesting and Hauling

C_s = Scaling

C_x = Highway Taxes

C_r = Roads

C_a = Administration

Q_n = Volume of Fibre Harvested in year n

Forest licencing costs (C_l) and transportation licencing costs (C_t) can be viewed as fixed costs. Harvesting and hauling costs (C_h), scaling costs (C_s), highway taxes (C_x) and dues and fees (C_d), are variable and are incurred on a per-cubic-metre harvested basis.

In order to effectively compare fibre procurement costs and to determine whether economies of scope are present, total fibre procurement costs must be broken down and expressed as average fibre procurement costs. The unit of measure under the average fibre procurement cost is the cost per cubic metre harvested. This is calculated by dividing total fibre procurement cost by the total volume of fibre harvest within the period (in cubic metres). The calculation for average cost is expressed in equation 4.2.

$$AC_f = TC_f/Q_n \qquad (4.2)$$

During the course of the case study, it was revealed that a significant portion of the fibre harvested is unsuitable for the IOs' production processes. This unutilized residual fibre presents IOs with an interesting challenge in that there are currently no established markets in which the fibre can be sold. As such, cost recovery opportunities on residual fibre are non-existent and the residual fibre generated in the procurement process can be a significant cost. In order to present an accurate picture of average fibre procurement costs, this waste component must be considered by estimating the effective fibre procurement cost, which is calculated by dividing the average fibre procurement cost by the utilization rate for the fibre harvested in that period (equation 4.3).

$$AC_{ef} = AC_f/U \quad (4.3)$$

where U is the utilization rate, which is the percentage of total fibre that can be utilized in the IO production process and is not classified as waste.

4.2.1 Forest Inventory Costs

For modelling purposes it is assumed that all of the IOs have equal annual allowable cuts, invest equal amounts in timber cruising, budget equal amounts to the same harvesting activities and have equal feasibility and utilization standards. The assumption that IOs have similar cost structures is further supported by the fact that these competitive firms sell their products for similar prices in competing markets, compete for inputs in a small local market, operate similar sized mills in the same geographical area, and employ approximately the same level of technology in their operations. The basic total cost model for timber cruising is a function of labour costs, aerial survey costs, equipment costs, travel costs, and research camp costs. The total forest inventory cost includes all timber cruising costs and is given by:

$$C_f = x_l{*}w_l + x_a{*}w_a + x_t{*}w_t + k + r \quad (4.4)$$

where,

x_l = number of labour hours spent on forest inventory analysis

w_l =forester wage rate

x_a =number of hours in aircraft

w_a =cost per hour for aircraft

x_t =number of km travelled

w_t =cost per km of travel

k =timber cruising equipment costs

r =research camp costs

4.2.2 Forest and Transport Licencing Costs

In order to ensure that forest licencing and transport licencing costs are directly comparable, we must also operate under the assumption that all IOs follow the same forest licencing process. Costs are calculated in the following equations:

$$C_l = w_l{*}x_d + w_m{*}x_n + w_l{*}x_r + w_l{*}x_e \quad (4.5)$$

where,

w_l = foresters' wage rate

x_d = labour hours spent developing annual operating plan

w_m = upper management/owner wage rate

x_n = labour hours spent negotiating forest licencing agreement

x_r = labour hours spent conducting reporting activities for forest licencing agreement

x_e = labour hours spent engaging in related enforcement activities

Forest licencing costs are independent of harvest volumes and, as such, represent a fixed cost. This reinforces the assumption that IOs face similar cost structures as illustrates that variance in IO fibre volume allocations will have no effect on forest licencing costs. Similarly, the costs associated with transportation licencing are not affected by variances in harvest volumes and represent a fixed cost. Regardless of the volume harvested, this transaction cost will remain relatively stationary, as the level of effort expended on transportation licencing does not change based on volume. The transportation licencing cost is illustrated in equation 4.6 below.

$$Ct = w_l*x_p + w_m*x_{np} + w_l*x_{rp} \quad (4.6)$$

where,

w_l = forester wage rate

x_p = labour hours spent developing and reviewing transportation partnership agreement

w_m = upper management/owner wage rate

x_{np} = labour hours spent negotiating transportation partnership agreement

x_{rp} = labour hours spent engaging in reporting activities for partnership agreement

4.2.3 Highway Tax Cost

Highway taxes are variable and change in direct proportion to the volume of timber hauled. In order to model these cost we assume that IOs face a similar cost structure. Finally, it must be assumed that the volume harvested is equal to the volume hauled, that is, all timber must leave the forest in the same period in which it was harvested. This assumption is not entirely essential for prior periods where we have hauling data but it is essential for forecasting future periods using the model. The following equation expresses highway taxes in a given year:

$$Cx = t_h * Q_n \tag{4.7}$$

where,

t_h = Highway tax rate for a given year (in \$/m^3)

Q_n = Volume of fibre harvested in given year (in m^3)

4.2.4 Harvesting Costs

In the factual model, harvesting costs make up the largest portion of IO fibre procurement costs. Harvesting costs are variable and change in direct proportion to the volume of fibre harvested. Larger IOs contract fibre-harvesting activities to logging contractors while the smaller IOs engage in small-scale harvesting operations using small-sized equipment. Following discussions with the sample IO and IFOS, it was discovered that IOs accept their fibre in a variety of forms and that the form of delivered fibre changes based on the equipment operated by the logging contractor and mill processing capacity. While some mills have contractors who run harvesting operations that are suited to the production of tree-length fibre others have contractors who run cut-to-length harvesting operations. In a tree-length operation, contractors deliver fibre to the mill in tree-length form and the mill uses a slasher or buckers to cut the fibre into the desired lengths. Whereas in a cut-to-length operation, contractors use a processor to cut the fibre to the desired lengths during the harvesting process and deliver fibre to the mills in cut-to-length form.

In the latter case, contractors charge higher rates as they engage in a higher level of processing than if they were delivering tree length logs to the mill. However, the mills' processing costs are lower as they do not need to expend additional effort to get fibre cut to the desired length. This type of harvesting is exemplified in the first part of the harvesting cost equation. The second part of the harvesting cost equation illustrates the cost of receiving fibre in tree-length form. In that situation, contractors charge a lower rate but the mill must engage in a higher level of processing to get fibre to the desired length, and thus the mills' processing costs are higher in a tree-length operation. In some cases, mills receive fibre in both forms. The factual model harvesting cost equation shown below incorporates this reality and provides a flexible representation of IO fibre harvesting costs.

$$C_h = h_c * Q_{nc} + h_t * Q_{nt} + s_t * Q_{nt} \tag{4.8}$$

where,

h_t = tree-length harvesting rate paid to contractors (in $/m^3)

h_c = cut to length harvesting rate paid to contractors (in $/m^3)

s_t = slashing/bucking cost (in $/m^3)

Q_{nt} = Volume of Fibre Harvested in Given Year as tree-length (in m^3)

Q_{nc} = Volume harvest in given year as cut to length (in m^3)

and,

$Q_{nt} + Q_{nc} = Q_n$

4.2.5 Crown Dues and Reforestation Fees

Similar to harvesting costs, crown dues and reforestation fees are variable and are based on the volume of wood harvested. Crown dues are timber royalties charged by the government for every cubic metre of timber harvested. Rates are calculated on a quarterly basis by the Forest Service and are based on a formula, which considers market prices, operating costs, etc. in determination of the acceptable royalty for that type of timber. Since the IOs are focused only on harvested softwood timber, we only have two crown due rates to incorporate: the S1 rate (for timber with a diameter greater than 6 inches) and the S2 rate (for timber with a diameter less than 6 inches). Given that the cost of crown dues is the volume of each size class harvested multiplied by the respective crown dues rate, one could easily incorporate additional variables to reflect the harvesting of various types of timber with varying dues rates.

Reforestation fees are calculated in a manner similar to crown dues. The major difference is that there is generally only one reforestation rate applied to all timber harvested regardless of size. Another key difference is that unlike crown dues, which carry the same monetary obligation province wide, reforestation fees vary by FMA. Fees are calculated by the FMA holder who is generally responsible for all reforestation activities and are meant to reflect the actual cost of reforestation in the FMA.

Many IOs hold allocations in multiple FMAs and, as such, it was necessary to reflect this reality in the calculations. This was easily achieved by including parameters for harvest volume from each FMA and the reforestation rate associated with each FMA. While we have only included two in our model to reflect the number of FMAs in which the sample IO firm holds an allocation, it is possible to add an infinite number of FMA harvest volume and reforestation rate parameters to reflect harvesting activities in any number of FMAs. The Crown dues and reforestation fee cost model developed for the factual model is given by:

$$C_d = r_{s1}*p_{s1}*Q_n + r_{s2}*p_{s2}*Q_n + r_{f1}*Q_{n1} + r_{f2}*Q_{n2} \quad (4.9)$$

where,

r_{s1} = S1 crown dues rate (in $\$/m^3$)

r_{s2} = S2 crown dues rate (in $\$/m^3$)

r_{f1} = Reforestation fee in FMA 1 (in $\$/m^3$)

r_{f2} = Reforestation fee in FMA 2 (in $\$/m^3$)

p_{s1} = Proportion of S1 Fibre Harvested

p_{s2} = Proportion of S2 Fibre Harvested

Q_{n1} = Volume of fibre harvested in FMA 1 in given year (in m^3)

Q_{n2} = Volume of fibre harvested in FMA 2 in given year (in m^3)

Q_n = Total volume of fibre harvested in given year (in m^3)

and,

$$Q_n = Q_{n1} + Q_{n2}$$

4.2.6 Scaling Costs

In order to assess the timber for crown dues, it must be scaled using one of the government–approved weight or volumetric scaling methods. Typically, contract services are used on a fee basis per cubic metre scaled. Thus, scaling costs in the factual model variable and can be expressed as:

$$C_s = s_c*Q_n \quad (4.10)$$

where,

s_c = Scaling consultant fee (in $\$/m^3$)

Q_n = Volume of fibre harvested in given year (in m^3)

4.2.7 Road Building and Reclamation Costs

In order to access harvest blocks and remove harvested timber, roads must be built. In addition, to remain compliant with environmental regulations these roads must be reclaimed and “rolled back” to limit access to regenerating forest areas. IOs generally contract these services, often to the same firm that is providing harvesting and hauling services. As such road building and reclamation costs represent a variable cost that can be expressed by:

$$C_r = k_r{*}Q_n \qquad (4.11)$$

where,

k_r = Road building and reclamation contracting rate (in $/m^3$)

Q_n = Volume of fibre harvested in given year (in m^3)

4.2.8 Administration Costs

The final fibre procurement cost, the administration cost, is fixed. The costs in this category represent a number of transaction costs including negotiation costs and enforcement costs. The first pair of parameters represents the costs associated with negotiating the required harvesting, hauling, road building and reclamation contracts with forestry contractors. The second set of parameters represents the costs associated with conducting harvesting site visits to ensure that operations are proceeding according to the operating plan and contract. The next set of parameters pertains to the costs associated with managing the contractors; considered an enforcement cost. The final set of parameters measures the costs associated with conducting administrative activities related to the forestry department such as payroll, accounts payable, data entry, and reporting. The administration cost equation is given by:

$$C_a = w_m{*}x_{cn} + w_l{*}x_q + w_m{*}x_m + w_a{*}x_a \qquad (4.12)$$

where,

w_a = administrative assistant wage rate

w_l = foresters wage rate

w_m = upper management/owner wage rate

x_{cn} = labour hours spent negotiating with forestry contractors

x_a = labour hours spent engaged in administrative activities related to forestry dept

x_m = labour hours spent managing forestry contractors

x_q = labour hours spent engaging in quality control

4.3 The IO NGC

Given that the costs associated with fibre procurement represent the most significant cost in forest product production (Niquidest and O'Kelly, 2008), it would seem logical that the IO NGC should focus on reducing fibre procurement costs. The most obvious way that a cooperative would be able to achieve cost reductions in this area is through creating an economy of scale by collectively procuring IO fibre volumes. Much like a woodlot/private landowner cooperative, the IO NGC would manage all of the IOs' fibre allocations as one unit. This would include every aspect of forestry management from forest inventory analysis, to developing harvesting and scaling plans, conducting stakeholder consultations, consulting with Saskatchewan Environment's Forestry department during the plan approval process, managing harvest operations aimed at harvesting the fibre that the IO mills require, as well as acquiring and managing relationships with all required contractors. By having the cooperative collectively manage the members' allocations as one unit, the group will have a large enough volume to sustain full-time foresters and seasonal forestry staff who can work with the members to ensure that they receive good quality rough wood of the right species and size class when needed. In addition, the forester will be able to provide members with increased access to technical skills and knowledge that is often lacking.

Management of the IOs' much larger collective allocation volume also provides the group with increased volume buying power, much like a traditional supply cooperative. This is important as it is often the case that the IOs who sub-contract their harvesting often have some difficulty securing long term contractors at competitive prices. By offering contractors a much larger harvest volume they should be able to secure more competitive rates, and to develop stable, long-lasting working relationships. The increased volume buying power would also allow the cooperative to negotiate more competitive prices on all other supplies associated with forestry management and thus further reduce fibre procurement costs.

Collectively managing the IOs' fibre volumes also presents both the IOs and the Government of Saskatchewan with an opportunity to reduce transaction costs through a reduction in the number of permits that IOs must create and the Ministry of Environment must process. Currently, all IOs with timber allocations must prepare harvesting and scaling plans that must then be reviewed by one the Ministry's Foresters who will then meet, often more than once, with a representative from the company submitting the plan. In many cases, it is the higher paid company and ministry representatives who end up spending a substantial portion of their time reviewing plans for relatively small fibre volumes and this further adds to the inefficient negotiation costs that both IOs and government face. In the counterfactual case, where the cooperative would manage the IOs' allocation as one unit, there would only be one harvesting and scaling plan created that would encompass all of the members' volumes and as such the Ministry of Environment would only have to meet with one individual, more than likely the coop's forester, during the plan development and approval process. This would have the effect of significantly reducing the negotiation costs for both IOs and the Government of Saskatchewan. In addition, the IOs will be able to achieve further negotiation cost reductions by developing only one harvesting plan.

There are also some much less obvious benefits, which collective management of the IOs' allocations could provide. The first of these is the reduction of timber cruising costs through elimination of "the multiple cruise effect." The multiple cruise effect is a competitive inefficiency that occurs when firms that operate within the same geographical area under a competitive forest tenure system, such as that in Saskatchewan, raise industry fibre costs by failing to share the results of their timber cruises with one another. The lack of information sharing commonly results in multiple companies cruising the same stands and coming to the same no-harvest conclusion. Had information been shared, firms would not have wasted resources cruising the same stands. The failure to share positive results of cruises can potentially increase costs in two ways. Firstly, the failure to inform other firms that the stands that were cruised were good stands that the firm decided to include in their permit and set aside for future-year harvesting operations result in companies expending unnecessary resources to find stands unavailable. Second, failure of one firm to inform another of quality material that does not suit their needs can increase the other firm's search costs in the event of several unsuccessful cruises before they find suitable timber. In the counterfactual case, where the coop performs all of the timber cruising for the IOs, all stands would only be cruised once and IO firms would no longer be acting individually or competitively. Appendix C contains a more detailed discussion on the existence of competitive inefficiencies associated with the multiple cruise effect.

Collective management of the IOs' fibre allocations also provides an opportunity for increased fibre utilization. This would be achieved through the formation of a cooperatively managed log sort yard. In this scenario, timber harvested by the cooperative would first be delivered to a log sort yard in a location central to the IO NGC members' mills. Once the tree-length fibre arrived at the sort yard it would be processed and then sorted by species, length, diameter class, and quality. Member mills would order the desired quantities of each type of fibre required and the cooperative would then subcontract delivery of the raw logs to their destination mills. Given that some members of the potential IO NGC require small-diameter White Spruce (*Picea glauca)*, Black Spruce (*Picea mariana*), and Jack Pine (*Pinus banksiana*), while others require large-diameter material, the cooperative should, in theory, be able to target stands that will provide sufficient quantities of the various species and diameter classes required to meet the needs of IO mills. The result of this system would potentially be that all member mills would receive their entire allocations in raw products that could be directly converted to saleable products. This is much different from the current situation in which most mills end up harvesting a significant amount of rough wood that is either too large or too small and end up having to sell the unusable rough wood, often at a discounted rate. This can significantly decrease utilization rates and thus increase rough wood costs. A log sort yard might instead create a situation in which utilization rates are maximized and rough wood costs are further reduced.

Despite the fact that utilization rates for individual mills might be increased, there will always be residual fibre. While the cooperative will be able to sell residual fibre into pulp and hog fuel markets on a cost recovery basis, it is unlikely that the cooperative would generate profit without the development of new markets for waste products. Although this represents a short term challenge it also provides the cooperative with a long term goal when we look at how the cooperative should evolve. A large number of agriculture cooperatives and a handful of forestry cooperatives such as the Koocanusa Value Added Cooperative (KVAC) have found that by adopting the NGC model they were able to extract additional values (Kinnis and Smith, 2003).

4.3.1 IO NGC Share Structure

The IO NGC would use the NGC model's unique three-class share structure to confer various rights to its membership. Membership in the NGC would be limited to those IOs who hold allocations in the PAFMA or Island Forest FMA. The primary reason for this limitation in membership is that the majority of IOs within the province hold allocations that are only valid in the two FMAs. Second, these FMAs are located in close geographical proximity to one another and to the majority of the existing IO mills. Including IOs with allocations in FMAs on the far eastern and western sides of the province would likely inflate transportation costs and erode any reductions in costs generated from membership in the IO NGC. Each IO firm would be granted one class A “membership share”. Class A shares would confer voting rights to members by entitling each Class A shareholder to one vote within the cooperative; thereby upholding the one member one vote principal inherent in the cooperative model.

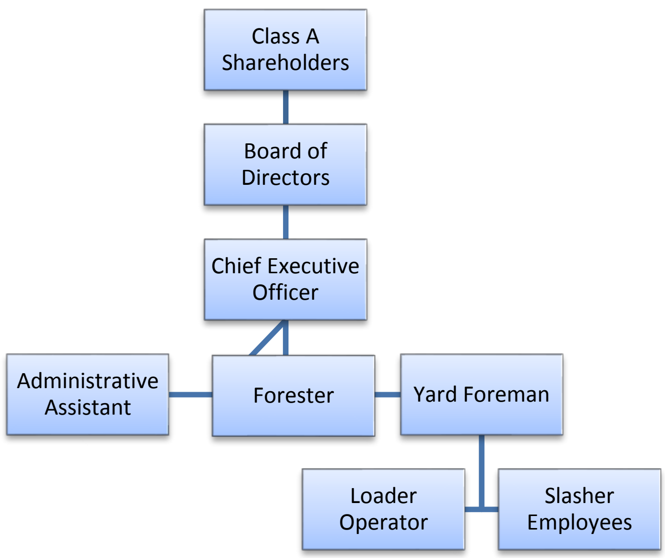
The second class of shares, Class B shares, are generally recognized within the literature pertaining to NGCs as “delivery shares” and confer shareholder’s with the right to provide a specified quantity of goods to an NGC for value added processing or marketing. In this case, the IOs will be using the NGC to supply goods and services rather than value added processing and marketing, so the term “delivery shares” is not entirely appropriate. In the IO case, Class B shares will be called “procurement shares”. Each IO will be issued one Class B “procurement share” for every cubic metre of wood allocation they pool into the cooperative allocation. In turn, each Class B share would entitle its holder to purchase one cubic metre of raw wood from the cooperative at the cooperative fibre procurement cost. Class B shares would also be used to generate initial internal investment from cooperative members. This would be accomplished by attaching a share value to each class B share. Prior to shares being issued, IOs would be required to pay the IO NGC a pre-specified price for each share issued. This cash would be utilized to fund start-up costs or to leverage financing for the same purpose. Lastly, Class B shares would also function as a dividend-bearing share, should the cooperative issue dividends in future years. In this case, the total dividends declared would be divided amongst members based on the total proportion of class B shares each member holds.

The third class of shares, Class C “investment shares”, present the IO NGC with a unique opportunity to generate additional funds for capital investments from both internal and external sources. The redeemable Class C “investment shares” would be non-voting, interest bearing shares, which could be issued to both members and non-members. Each Class C share would entitle its holder to a dividend that is based on a pre-determined interest rate multiplied by the initial share value.

4.3.2 IO NGC Organizational Structure

The Class A shareholders will be charged with the responsibility of democratically selecting the board of directors and voting on all major changes to the structure or function of the cooperative. The board of director's will, in turn, be responsible for directing the overall goals of the corporation, engaging in strategic planning, and hiring the cooperative's chief executive officer (CEO). The CEO will be charged with the responsibility of managing the businesses day to day affairs, promoting and representing the IO NGC, hiring and managing all other employees within the corporation, engaging in activities related to achieving the goals of the cooperative, and reporting to the board of directors.

Figure 4.1: IO NGC Organizational Structure



The log sort yard employees, including the loader operator and slasher operator, will be accountable to the yard foreman, who is, in turn, accountable to the CEO. The administrative assistant will conduct the cooperative's administrative functions, including bookkeeping activities, and will be directly accountable to the CEO. Lastly, the forester will be responsible for all forest management and planning activities and will answer directly to the CEO. The IO NGC organizational structure is depicted in Figure 4.1.

4.4 IO NGC Fibre Procurement Process

The section outlines the various stages of NGC fibre procurement process. Under this process all aspects of fibre procurement would be delegated to the NGC. IOs would simply be responsible for informing the NGC of their fibre type and quantity requirements at the beginning of each operating year. The various stages and sub-processes in the IO NGC fibre procurement process are described below.

4.4.1 Forest Inventory Analysis

Forest inventory analysis is the most important part of the fibre procurement process as it determines the quantity, quality and proximity to the mill of the timber that will be harvested by the firm. The IO NGC will be responsible for all forest inventory analysis activities including: timber cruising, ground surveying, aerial surveying, stand data analysis, stand selection and mapping are included in this stage.

4.4.2 Forest Licencing

Forest licencing involves the development, negotiation, reporting, and enforcement activities associated with acquiring and maintaining forest tenure. Under the IO NGC, tenure would be granted under a 10 year volume based TSL within the Prince Albert FMA. As a requirement of holding the TSL, the cooperative would be charged with the responsibility of developing an annual operating plan. The IO NGC forester would conduct all necessary reporting activities including the development of monthly wood flow reports and annual reports. In addition to reporting activities, the forester will also carry out enforcement activities such as periodic operating block inspections ministry staff and working with contractors to address any noted deficiencies.

4.4.3 Transportation Licencing

The transportation licencing process begins with the joint development of a transportation partnership agreement with the Ministry of Highways and Infrastructure. The partnership agreement identifies the primary hauling routes that the IO NGC will use to transport timber and sets out the highway tax that will be applied to each tonne of timber hauled. Reporting and administrative activities associated with the agreement will be delegated to the IO NGC forester.

The IO NGC will provide the ministry with quarterly highway tax remittances and summary reports for all fibre harvested by the IO NGC.

4.4.4 Timber Harvesting and Road Building

One of the primary advantages of cooperative fibre procurement among IO mills, via the IO NGC, is the marketing of larger timber harvest volumes. More specifically, larger timber harvest volumes are more attractive to potential contract logging firms who will be hired to harvest timber for the IO NGC. Larger fibre volumes are more attractive to potential logging contractors as they provide increased revenue potential and reduced transaction costs associated with negotiating, administering, and maintaining contracts. In most cases, individual IO mill harvest volumes would be so low that it is unlikely that they would be able to find a logging contractor that would be willing to take on their harvesting contract. If they are able to find a contractor who is willing to perform low volume cuts, the contractor will generally demand higher prices and only commit to performing the work after their larger volume harvest contracts have been completed (Vermette, 2009). As such, the cooperative presents a new opportunity for IOs to access more economical harvesting services than they are currently able to.

Under the suggested model, timber harvesting would be contracted to independent logging firms that utilize mechanical harvesting systems in their operations. Logging contractors would be required to harvest timber in tree-length form and to deliver tree-length fibre to the log sort yard. Additionally, logging contractors would be contracted to provide road building and maintenance services for all required harvesting block access roads.

4.4.5 The Log Sort Yard

The primary mechanism that the IO NGC will use to increase fibre utilization and thus decrease the effective cost of fibre procurement is the log sort yard. Log sort yards have been widely used throughout North America as a means of increasing fibre utilization and ensuring that fibre is allocated to its highest value end use. In fact, most large forest product companies have integrated log sort yards into their business model to increase utilization and mill productivity.

In order to operate effectively and to ensure that operation costs are minimized the IO log sort yard will need to meet a number of conditions related to location of the log sort yard. More specifically, the location of the log sort yard must satisfy conditions pertaining to proximity to timber harvesting areas, proximity to existing IO mills, proximity to transportation infrastructure, and proximity to well-developed labour markets.

Condition 1: Proximity to Harvesting Areas

Given the large effect that timber hauling costs have on overall fibre procurement costs, it is intuitive that those sites which minimize the distance from timber harvesting areas to the log sort yard will provide the greatest degree of timber hauling cost minimization. Additionally, given that the IO NGC will be sourcing fibre from two FMAs that cover a large geographical area it becomes especially important that any potential log sort yard site be located in an area central to the two FMAs from which fibre will be sourced.

Condition 2: Proximity to Existing IO Mills

Since sorted fibre will need to be redirected from the log sort yard to each of the IO mills, the distance from the log sort yard to IO mills must also be considered. In order to minimize fibre delivery costs from the log sort yard to the IO mills, the log sort yard should be located in an area central to the existing IO facilities.

Condition 3: Proximity to Transportation Infrastructure

Given that trucking is primary method of fibre transportation in this region of Canada, the most important form of transportation infrastructure for the IO NGC is highways. More specifically, class 1 and class 2 highways with the largest weight capacities allow for the largest volume of fibre per truck to be hauled and thus reduce transportation costs. Therefore, those sites located closest to class 1 and class 2 highways will minimize transportation costs and overall fibre procurement costs.

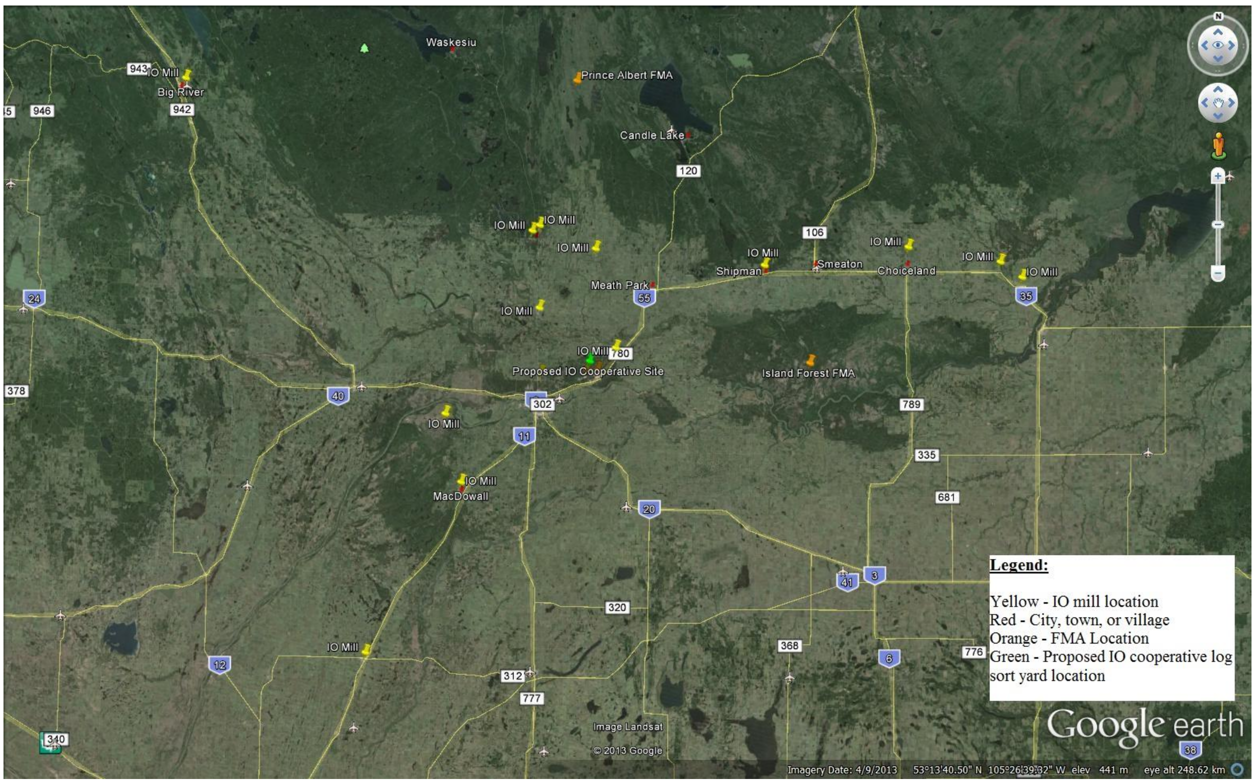
Condition 4: Proximity to Well Developed Labour Markets

Operation of a log sort yard requires an ample supply of skilled labour be readily available. Moreover, economical operation of the log sort yard will require that labour costs are not inflated by high travel costs. As such, those sites that are in close proximity to well-developed labour markets will provide the greatest supply of skilled labour at the lowest cost and further decrease overall fibre procurement costs.

Log Sort Yard Location

Given the four conditions presented above, the most suitable site for an IO log sort is the Buckland Industrial Park, located 15 km east of Prince Albert, SK on highway #55 (the proposed location is indicated by a green marker on figure 4.2). In addition to being located in an area central to timber harvesting areas (denoted by orange markers in figure 4.2) and existing IO mills (denoted by yellow markers in figure 4.2), the Buckland Industrial Park is located adjacent to a primary class 1 highway and in close proximity to Prince Albert, SK, a city with a well-developed labour market.

Figure 4.2: IO Mill Locations in Relation to the IO NGC Log Sort Yard and FMAs



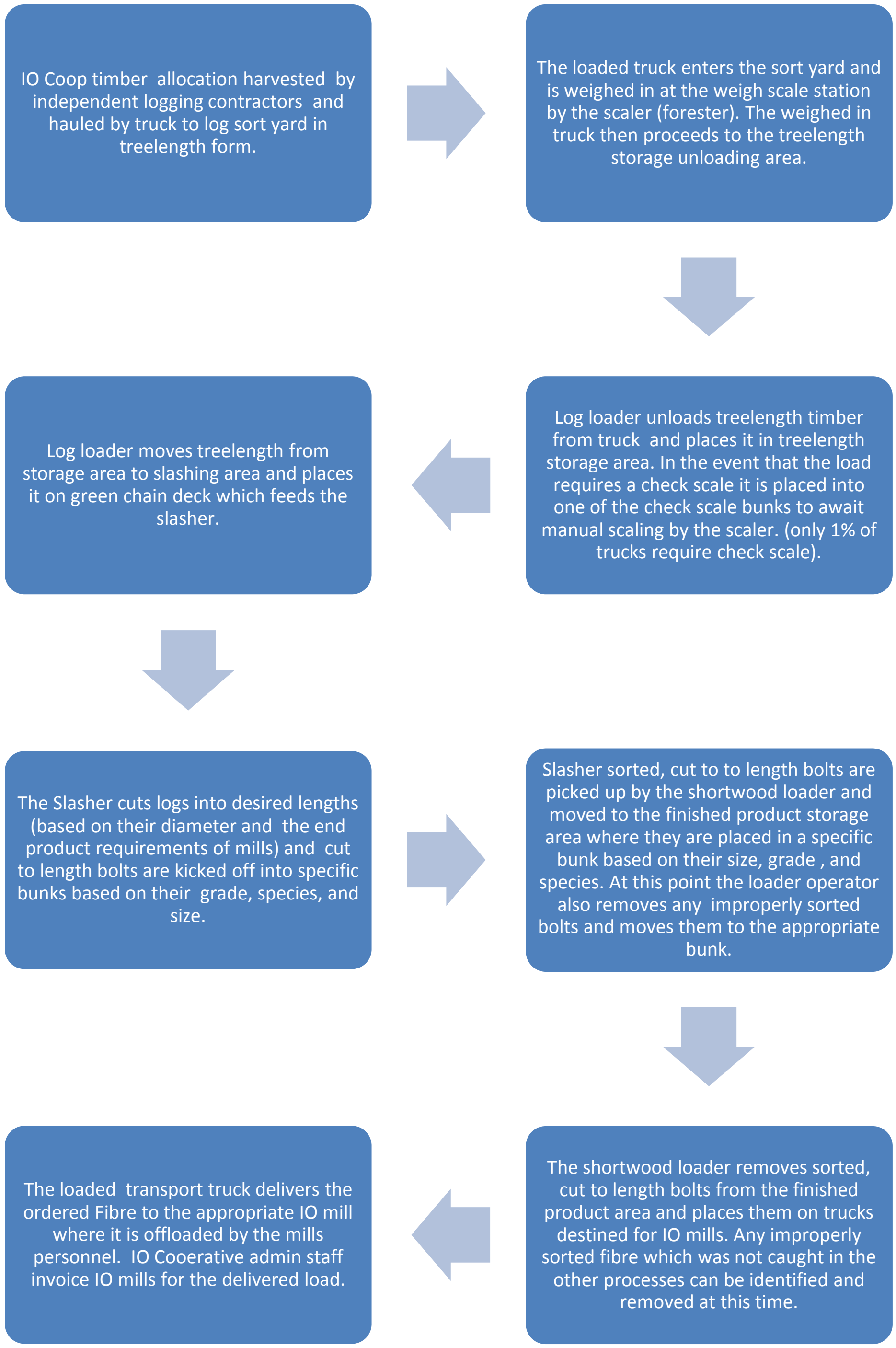
Log Sort Yard Process Map

There are several crucial processes that are carried out at the log sort yard. When tree-length fibre arrives at the sort yard, it will immediately weight scaled for crown dues and reforestation fees. To ensure the accuracy of the weight scale and to remain compliant with provincial regulations, incoming loads will be sample scaled at a frequency of 1%. Sample scale loads will be moved to the adjacent sample scaling area where a forester will conduct manual volumetric scaling. Completed sample scale loads will remain in the sample scaling area for 48 hours to allow for potential check scaling by Ministry of Environment staff. The remaining 99% of loads will be moved directly to the tree-length storage area where they will be offloaded from the truck and placed in the storage area to await further processing. Loaders will be used to carry tree-length fibre from the storage area to the slashing area where it will be cut into several lengths that are suitable for IOs production processes. Cut to length fibre will then be moved from the slashing area to the sorting area where it will be graded and sorted by size, species, and grade. Sorted logs will be moved to the finished goods storage area to await shipment to IO mills.

Under this system IO mills will have the flexibility of ordering and receiving only fibre that meets their production specifications. This will allow them to use their entire allocation in their production process and will increase their utilization to 100%, assuming that their individual production process do not generate large amounts of waste that cannot be sold on a cost recovery basis. Once IO mills have placed an order for fibre, the IO NGC will contract a fibre hauling firm to deliver the required amount of logs to the respective IO mill. By utilizing the same firm as was used to haul tree-length, the IO NGC will be able to garner more volume buying power and would ideally be able to negotiate the best possible hauling price.

Once the IO mill receives their fibre from the sort yard, administrative staff will invoice the IO mill for the fibre and the IO mill will remit payment to the cooperative under a set of pre-established terms. Upon receipt of payment by the IO NGC, the IO mills purchase contract for that portion of their volume is complete. This process will continue to repeat for each IO mill until they have received and paid for their entire annual fibre allocation. It is important to note that the IO NGC will need sufficient financial capital to operate and to provide all of the aforementioned services. The cooperative will likely need to employ a combination of government financing, bank financing (i.e. an operating line) and shareholder financing (i.e. through investment shares) to generate sufficient financial capital.

Figure 4.3: IO NGC Log Sort Yard Process Map



4.5 The Counterfactual Model

The counterfactual model represents the cost of fibre procurement under the IO NGC. It is based on the business as usual case (equation 4.1), but includes key differences pertaining to the calculation methods for harvesting, scaling, and administration costs and the addition of log sort yard operational costs and sorted fibre delivery costs. The changes are presented in the sections that follow. For greater detail on the cost components not described within the sections that follow, readers are referred to section 4.1.

4.6 Counter-factual Model Assumptions

1. The IO NGC has some market power and volume buying power. The cooperative is able to access premium pricing equal to that obtainable by large industry.
2. The IO NGC is profit maximizing.
3. The IO NGC operates as its own business entity.
4. Inflation is present at the rate of 2% per annum.
5. Due to the presence of larger residual volumes, it is now possible to sell accrued residual fibre into existing pulp and hog fuel markets.

4.7 The Counter-Factual IO NGC Fibre Procurement Costs

The counter-factual model is based on the nine cost components of the original factual model, but also incorporates the cost of operating the log sort yard (Cy) and the cost of delivering fibre from the log sort yard to IO mills (Cm). That being said, it is important to note that not all cost components are calculated in the same way as they previously were in the factual model. The reasons for this are varied and will be discussed on a component by component basis in the coming sections. The total fibre procurement cost model under the IO NGC is presented below.

$$TC_{cf} = C_i + C_d + C_l + C_t + C_h + C_s + C_x + C_r + C_a + C_y + C_m \tag{4.13}$$

And,

$$AC_{cf} = TC_{cf}/Q_n \tag{4.14}$$

And,

$$AC_{ecf} = AC_{cf}/U \tag{4.15}$$

Where,

C_i = Forest Inventory Cost

C_l = Forest Licencing Cost

C_t = Transportation Licencing Cost

C_x = Highway Tax Cost

C_h = Harvesting Cost

C_d = Dues and Fees Cost

C_s = Scaling Cost

C_r = Road Cost

C_a = Admin Cost

C_y = Log Sort Yard Cost

C_m = Delivery Cost (Sort Yard to IO Mill)

Q_n = Volume of Fibre Harvested in Given Year (in m^3)

TC_{cf} = Total Cost of Fibre in Counter-factual Case

AC_{cf} = Average Cost of Fibre in Counter-factual Case

AC_{ecf} = Average Effective Cost of Fibre in Counter-factual Case

U = Utilization Rate

4.7.1 Harvesting Costs

In the counterfactual model, harvesting costs reflect the fact that the IO NGC will only be accepting their fibre in tree-length form. All harvesting will be contracted to logging contractors who will provide delivered tree-length to the log sort yard. This is reflected in the first part of the harvesting cost equation shown below. Next, the IO NGC log sort yard will be responsible for cutting all the fibre to the lengths desired by IO mills. The costs associated with the slashing process are depicted in the second part of equation 4.8 which is given by:

$$C_h = h_t*Q_n + s_t* Q_n \tag{4.16}$$

Where,

H_t = tree-length harvesting rate paid to contractors (in $/m^3)

s_t = slashing cost (in \$/m^3)

Q_n = Volume of Fibre Harvested in Given Year (in m^3)

4.7.2 Scaling Costs

Scaling costs include the cost of measuring and assessing the harvested timber for crown dues and reforestation fees. The scaling cost function in the IO NGC model varies from that utilized in the factual “business as usual” model in that it calculates scaling costs associated with the weigh scale method instead of the manual scaling method. Scaling costs under the IO NGC model are given by:

$$C_s = ((Q_n * f_s)/s_p) * w_l + k_s \qquad (4.17)$$

Where,

f_s = Sample scaling frequency (in %)

k_s = Annual capital cost of weigh scale equipment (in \$)

s_p = Scaler productivity (in m^3/hr)

w_l = Foresters wage rate

Q_n = Volume of fibre harvested in given year (in m^3)

4.7.3 Co-op Administration Costs

The co-op administration procurement cost component is made up costs that are largely fixed. The costs in this category represent a number of transaction costs including negotiation costs and enforcement costs, as well as general and administrative expenses associated with operating the cooperative. The first parameter represents the general and administrative expenses associated with operating the cooperative. The second pair of parameters represents the costs associated with negotiating the required harvesting, hauling, road building and reclamation contracts with forestry contractors. While the third set of parameters represents the costs associated with conducting harvesting site visits to ensure that operations are proceeding according to the operating plan and contract. The next set of parameters pertains to the costs associated with managing the contractors, also an enforcement cost. This would involve meetings between the IO and contracting firm’s management to discuss progress and any issues related to the contract. The final set of parameters contains measures the costs associated with conducting administrative activities related to the forestry dept. Such as payroll, accounts payable, data entry, and reporting. As was noted earlier, these costs are largely fixed and as such there are no parameters related to harvest volume in our administration cost equation which is given by:

$$C_a = k_o + w_m*x_{cn} + w_l*x_q + w_m*x_m + w_a*x_a \qquad (4.18)$$

Where,

k_o = annual general and administrative expenses

w_a = administrative assistant wage rate

w_l = foresters wage rate

w_m = chief executive officer wage rate

x_{cn} = labour hours spent negotiating with forestry contractors

x_a = labour hours spent engaged in administrative activities related to forestry dept.

x_m = labour hours spent managing forestry contractors

x_q = labour hours spent engaging in quality control

4.7.4 Log Sort Yard Costs

This cost component, that was not present in the factual model, reflects the costs associated with the operation of a log sort yard. It incorporates the costs of all activities conducted within the log sort yard except for slashing, which was previously included in harvesting costs. The general model for log sort yard costs is given by:

$$C_y = k_l + k_e + m + g + w_e*x_e + w_f*x_f \qquad (4.19)$$

Where,

k_l = annual capital cost of log sort yard (including land and buildings)

k_e = annual loader capital cost

m = repair and maintenance costs

g = fuel costs

w_e = loader operator wage rate

w_f = yard foreman wage rate

x_e = number of loader operator labour hrs required

x_f = number of yard foreman labour hrs required

4.7.5 Delivery Costs (Log Sort Yard to IO Mill)

The final cost component in the counter-factual model represents the cost associated with delivering fibre from the log sort yard to individual IO mills. The method for calculating delivery costs is slightly more complicated and involves multiple calculations. The primary delivery cost model is given below in 5.12 and is expressed simply as the number of loads multiplied by the cost of hauling per load. Hauling services are generally contracted out to hauling contractors who charge an hourly rate. In order to calculate hauling costs (h_m), we utilize equation 5.12.1 which utilizes the average distance from log sort yard to IO mills, the average travelling speed of the hauling vehicle and the hourly hauling rate to determine hauling cost per load. Finally equation 5.12.2 calculates the number of loads hauled annually by simply dividing the total fibre harvested by the average volume hauled per load. Following from this, fibre delivery costs are given by:

$$C_m = h_m * n_l \qquad (4.20)$$

Where,

h_m = Hauling cost per load ($/load)

n_l = Number of loads hauled annually

And,

$$h_m = (d_a/t_s) * p_h \qquad (4.21)$$

Where,

d_a = Average distance from log sort yard to IO mill (in km)

t_s = Average travelling speed of hauling vehicle (in km/hr)

p_h = Price of hauling services (in $/hr)

And,

$$n_l = Q_n/V_h \qquad (4.22)$$

Where,

Q_n = Volume of Fibre Harvested in Given Year (in m^3)

V_h = Average volume of fibre hauled per load (in m^3/load)

CHAPTER FIVE: RESULTS AND DISCUSSION

5.1 Factual Model Analysis

Data obtained through the case study was fitted to the factual model developed in Chapter Four to derive fibre procurement cost estimates under the business as usual case. Fibre procurement cost estimates for the IOs are measured in $\$/m^3$ and are listed in Table 5.1 according to the business as usual variables identified in Chapter Four. All costs, except for crown dues, reforestation fees, and highway taxes are subject to inflation at a rate of 2% per year over the five-year period. It has also been assumed that IOs are price takers that hold no market power and are, thus, subject to the same prices for inputs.

Given that all IOs are located south of the PAFMA boundary and outside of the Island Forest boundary, the assumption that all IO's harvest locations are located at an equal distance from their primary mill site was introduced. This assumption was supported by the fact that IO tenure rights allow them to target fibre throughout the PAFMA regardless of the target stand's longitudinal position in the FMA. The final assumptions utilized in the model are related to fibre utilization. First, it was assumed that all IOs face the same fibre utilization rates regardless of the final products that they produce and that this utilization rate was equal to that generated in the IO case study. Lastly, it was assumed that the absence of sufficient residual volumes does not allow for the sale of individual IO residual fibre to existing pulp and hog fuel markets.

The cost derived from the factual fibre procurement model form the base values against which the results of the counter-factual model will be compared. Upon running the model, it was immediately apparent that harvesting costs were, by far, the most significant costs in the fibre procurement process. Crown dues and reforestation fees were a distant and all other costs appeared relatively insignificant. The fibre utilization rate of 72% was surprisingly low and had an extremely significant effect on the effective cost of fibre procurement.

5.2 Counter-factual Model Analysis

Values obtained from the case study data collection and interview processes as well as data generated during the conceptual model development were fitted to the counter-factual fibre procurement cost model to generate fibre procurement costs for IOs under NGC model. Fibre procurement costs were modeled over a period of 5 years to allow for gradual integration of IOs into the cooperative and to reveal the feasibility of the cooperative at various participation rates and overall harvest volumes. In the analysis, it was assumed that IOs representing 20% of the total IO allocation volume across the PAFMA and Island Forest join the cooperative in the first year and that IOs continue to join at a rate that results in an additional 20% of total IO allocation volume being harvested by the cooperative every year until 100% of the total IO allocation is being harvested by the IO cooperative in year five.

Table 5.1: Factual Model Average Cost Function Year 1 through Year 5 (all values in $ per m harvested)

	Year				
	1	2	3	4	5
Forest Inventory	0.86	0.88	0.89	0.91	0.93
Forest Licencing	0.68	0.70	0.71	0.73	0.74
Transport Licencing	0.32	0.33	0.34	0.34	0.35
Harvesting	42.75	43.60	44.47	45.36	46.27
Dues & Refor.	5.82	5.94	6.06	6.18	6.30
Highway Tax	2.50	2.55	2.60	2.65	2.71
Roads & Reclam.	1.85	1.88	1.92	1.96	2.00
Scaling	1.50	1.53	1.56	1.59	1.63
Admin	2.09	2.13	2.17	2.22	2.26
Sort Yard*	0.00	0.00	0.00	0.00	0.00
Sort Yard to Mill Shipping*	0.00	0.00	0.00	0.00	0.00
Gross Cost	58.37	59.54	60.73	61.95	63.19
Utilization Rate (%)	72%	72%	72%	72%	72%
Effective Cost**	**81.07**	**82.70**	**84.35**	**86.04**	**87.76**

Assume all costs rise at rate of inflation except for dues & refor and highway tax, which are fixed.
*Sort Yard and Sort Yard to Mill Values are zero because these do not exist in factual case. The columns are simply there to aid in comparison

**Effective cost is measured as gross cost divided by utilization rate. This is the real cost for each unit of effective timber as you pay for all timber but can only utilize a portion in production.

All costs except for crown dues, reforestation fees, and highway taxes are subject to inflation at a rate of 2% per year as depicted in Table 5.2. It was assumed that due to the creation of economies of scale, the IO NGC has some market power and is able to access premium pricing equal to that obtainable by large industry. It was also assumed that the presence of economies of scope make it possible for the IO NGC to sell accrued residual fibre into existing pulp and hog fuel markets on a cost recovery basis. This assumption is a departure from the current reality where IOs lack the economies of scale and scope necessary to negotiate contracts and sell fibre to the existing pulp and hog fuel markets on a cost recovery basis. The final assumption relates to sort yard to mill shipping, a cost that was absent in the factual model. In order to avoid a number of implementation challenges including cost tracking, member participation rates and cohesion challenges related to distance to sort yard and sort yard to mill shipping rates, it is assumed that the IO cooperative will charge all members an equalized per cubic metre sort yard to milling shipping rate. This rate is calculated by determining the spatial location of IO mills and the average shipping distance to IO mills and then using market data to determine a per load cost. That per load cost is then broken down into a per cubic metre sort yard to mill shipping cost and extrapolated across the total number of cubic metre harvest by the IO cooperative to derive total sort yard to mill shipping costs. The calculations used to derive sort yard to mill shipping costs in the counterfactual model can be observed in tables B27, B28, and B29 located in Appendix B.

The fibre procurement costs generated under the counter-factual model exhibit results similar to the results generated under the factual model in that harvesting costs represent the most significant fibre procurement cost with crown dues and reforestation fees coming in at a distant second. The major departure in the results exhibited by the counter-factual is the inclusion of cooperative administration costs, sort yard, costs and sort yard to mill shipping costs that are similar in significance to crown dues and reforestation fees. Another major departure from the fibre procurement costs obtained under the factual model is the much higher utilization rate obtained by the IO cooperative and the corresponding effect, or lack thereof, on the effect cost of fibre procurement.

5.3 Comparative Analysis

After comparing the fibre procurement costs under both models it is clear that, in effective terms, the fibre procurement costs are lower under the counter-factual (IO NGC) model than they are under the factual (business as usual) model. Moreover, the results depicted in table 5.3 below reveal that the gap between fibre procurement costs in the factual model and counterfactual model widens as time progresses. In essence, revealing that as more IOs participate in the cooperative and the IO NGC's annual harvest volume increases, the cooperative is better able to achieve reductions in the effective cost of fibre procurement. This does not hold true in the case of gross costs. Instead gross costs in the counter-factual model exceed gross costs in the factual model in all years and at all harvest levels. Despite this, the increasing returns to scale observed in relation to gross costs and effective costs indicate that economies of scope and economies of scale are present.

Table 5.2: IO Cooperative Average Cost Function Year 1 through Year 5 (all values in $ per m harvested)

	Year				
	1	2	3	4	5
Forest Inventory	0.77	0.74	0.74	0.74	0.75
Forest Licencing	0.30	0.15	0.10	0.08	0.06
Transport Licencing	0.14	0.07	0.05	0.04	0.03
Harvesting	38.25	38.56	38.87	39.19	39.52
Dues & Refor.	6.04	6.16	6.28	6.41	6.54
Highway Tax	2.50	2.55	2.60	2.65	2.71
Roads & Reclam.	2.00	2.04	2.08	2.12	2.16
Scaling	0.13	0.08	0.06	0.05	0.05
Co-op Admin	5.82	2.66	1.68	1.56	1.19
Sort Yard	6.02	4.98	4.43	4.33	4.16
Sort Yard to Mill Shipping	5.40	5.40	5.40	5.40	5.40
Gross Cost	67.36	63.21	61.96	62.06	61.86
Utilization Rate (%)*	100%	100%	100%	100%	100%
Effective Cost**	**67.36**	**63.21**	**61.96**	**62.06**	**61.86**

* Model operates under the assumption that the cooperative achieves 100% utilization through sorting and delivering specific fibre to the appropriate IO mill.
* in the event that assumption does not hold, assume that unutilized fibre is sold to external mills on a cost recovery basis

**Effective cost is measured as gross cost divided by utilization rate. This is the real cost for each unit of effective timber as you pay for all timber but can only utilize a portion in production.

Tables 5.3 and 5.4 also confirm that the most significant per unit cost reductions are in harvesting costs, suggesting that economies of scale in relation to harvesting costs are present. The same can be said for utilization rates, which increase from 72% in the factual model to 100% in the counter-factual model using the assumption presented in section 5.2. Table 5.5 expresses the model variations in terms of percentage contributions to changes in the gross fibre procurement and illustrates the extent, origins, and significance of fibre procurement cost reductions. The majority of the costs do not have a significant effect on gross fibre procurement costs. The most significant cost changes are the increases generated by sort yard operation and the delivery of fibre from sort yard to mill sites. Cooperative administration costs represent a significant cost increase in year one but by year five, is greatly diminished. This reveals administration costs are affected by economies of scale achieved through increased harvest volumes. While harvesting and scaling costs decrease, it is not enough to reduce overall gross fibre procurement costs in all periods.

Table 5.3: Net Change in Average Cost Between Counterfactual (IO Cooperative) Model and Factual Model (all values in $ per m harvested)*

	Year				
	1	**2**	**3**	**4**	**5**
Forest Inventory	- 0.09	- 0.14	- 0.16	- 0.17	- 0.18
Forest Licencing	- 0.39	- 0.55	- 0.61	- 0.65	- 0.68
Transport Licencing	- 0.18	- 0.26	- 0.29	- 0.31	- 0.32
Harvesting	- 4.49	- 5.04	- 5.60	- 6.17	- 6.75
Dues & Refor.	0.22	0.22	0.23	0.23	0.23
Highway Tax	-	-	-	-	-
Roads & Reclam.	0.15	0.16	0.16	0.16	0.17
Scaling	- 1.38	- 1.46	- 1.50	- 1.54	- 1.58
Admin	3.73	0.53	- 0.49	- 0.66	- 1.07
Sort Yard*	6.02	4.98	4.43	4.33	4.16
Sort Yard to Mill Shipping	5.40	5.40	5.40	5.40	5.40
Change in Gross Cost	8.99	3.67	1.23	0.11	- 1.32
Change in Utilization Rate (%)	28%	28%	28%	28%	28%
Change in Effective Cost	**- 13.71**	**- 19.48**	**- 22.39**	**- 23.98**	**- 25.89**

* Comparison Calculated by Subtracting Factual Model Values from Counterfactual Model Values to yield the net change in average cost realized by the counterfactual model

However, the fact that the effective costs have decreased by 17% in year one and continue to decrease until they are 30% lower in year five reveals that the IO NGC is still more efficient than the current IO model. The results also suggest that at all participation rates modelled, except for the maximum participation rate, the cost reductions resulting from increasing economies of scope and scale are exceeded by the cost increases resulting from operation of the log sort yard and the additional leg of delivery required between the sort yard and IO mills. This result highlights the importance of the utilization rate which, in the end, is the largest contributor to fibre procurement cost reductions. If the utilization rate is below the 100% utilization rate employed in the counterfactual, does the IO cooperative still generate fibre procurement cost reductions? That question will be explored in the next section of this chapter.

Table 5.4: Net Change in Average Cost Between Counterfactual (IO Cooperative) Model and Factual Model (in %)*

	Year				
	1	2	3	4	5
Forest Inventory	-10%	-16%	-18%	-19%	-19%
Forest Licencing	-57%	-78%	-86%	-89%	-91%
Transport Licencing	-57%	-78%	-86%	-89%	-91%
Harvesting	-11%	-12%	-13%	-14%	-15%
Dues & Refor.	4%	4%	4%	4%	4%
Highway Tax	0%	0%	0%	0%	0%
Roads & Reclam.	8%	8%	8%	8%	8%
Scaling	-92%	-95%	-96%	-97%	-97%
Admin	179%	25%	-23%	-30%	-47%
Sort Yard*	Undefined	Undefined	Undefined	Undefined	Undefined
Sort Yard to Mill Shipping	Undefined	Undefined	Undefined	Undefined	Undefined
Change in Gross Cost	15%	6%	2%	0%	-2%
Change in Utilization Rate (%)	39%	39%	39%	39%	39%
Change in Effective Cost	**-17%**	**-24%**	**-27%**	**-28%**	**-30%**

*Sort Yard and Sort Yard to Mill Values are undefined because values for these variables did not exist in factual case. The rows are simply there to maintain consistency with previous tables.

Table 5.5: Net Wood Procurement Cost Reductions for IO Industry*

Year	Volume Harvested (in m^3)	Net Change in Average Effective Wood Procurement Cost	Net Change in Total Effective Wood Procurement Cost
1	40439	-$13.71	-$554,601.32
2	80878	-$19.48	-$1,575,845.36
3	121317	-$22.39	-$2,716,523.97
4	161756	-$23.98	-$3,878,817.13
5	202195	-$25.89	-$5,235,478.58

*This model assumes that by year 5 all IO allocations in both the PAFMA and Island Forest are being harvest by the IO cooperative.

*This model also assumes that IO mills accept delivery on 100% of their allocation volume during that year.

5.4 Sensitivity and Break Even Analysis

Sensitivity analysis of the factual model results confirm that changes in harvesting costs and utilization rates have the greatest effect on the effective cost of fibre procurement. In fact, the analysis revealed that a one percent change in the all other cost components, changed the effective cost of fibre procurement by less than one tenth of a percent. From the analysis, it can be observed that a one percent change in harvesting costs creates a positively correlated change of 0.74% in the effective cost of fibre procurement, a highly significant change by any measure. The results of sensitivity analysis reveals similar results for the counter-factual model. Again, it can be seen that the two only factors which have a significant effect on the effective cost of fibre procurement are harvesting costs and utilization rates. In the counter-factual case, harvesting costs have a lesser effect on the effective cost of fibre procurement than in the factual mode, with a one percent change in harvesting costs generating a positively correlated change of 0.57%.

Table 5.6: Factual Model Sensitivity Analysis Summary

	Current Values:	1% Increase in Forest Inventory Cost	1% Increase in Forest Licencing Cost	1% Increase in Transportation Licencing Costs	1% Increase in Harvesting Costs	1% Increase in Dues & Refor Fees	1% Increase in Highway Tax	1% Increase in Road Building Cost	1% Increase in Scaling Cost	1% Increase in Admin Cost	1% Increase in Utilization Rate	1% Decrease in Volume Harvested
Changing Cells:												
Forest Inv. Cost	0.860	0.869	0.860	0.860	0.860	0.860	0.860	0.860	0.860	0.860	0.860	0.869
Forest Lic. Cost	0.683	0.683	0.690	0.683	0.683	0.683	0.683	0.683	0.683	0.683	0.683	0.690
Trans. Lic. Cost	0.324	0.324	0.324	0.327	0.324	0.324	0.324	0.324	0.324	0.324	0.324	0.327
Harvesting Cost	42.745	42.745	42.745	42.745	43.170	42.745	42.745	42.745	42.745	42.745	42.745	42.745
Dues & Refor.	5.824	5.824	5.824	5.824	5.824	5.882	5.824	5.824	5.824	5.824	5.824	5.824
Highway Tax	2.500	2.500	2.500	2.500	2.500	2.500	2.530	2.500	2.500	2.500	2.500	2.500
Road Cost	1.847	1.847	1.847	1.847	1.847	1.847	1.847	1.870	1.847	1.847	1.847	1.866
Scaling Cost	1.502	1.502	1.502	1.502	1.502	1.502	1.502	1.502	1.520	1.502	1.502	1.502
Admin Cost	2.088	2.088	2.088	2.088	2.088	2.088	2.088	2.088	2.088	2.110	2.088	2.109
Utilization Rate	0.720	0.720	0.720	0.720	0.720	0.720	0.720	0.720	0.720	0.720	0.727	0.720
Result Cells:												
Effective Cost	81.074	81.086	81.083	81.079	81.664	81.155	81.116	81.106	81.100	81.104	80.271	81.156
% Change in Effective Cost		**0.0147%**	**0.0112%**	**0.0058%**	**0.7274%**	**0.0998%**	**0.0514%**	**0.0394%**	**0.0314%**	**0.0372%**	**-0.9901%**	**0.1004%**

Table 5.7: Counter-Factual Model Sensitivity Analysis Summary

	Current Values:	1% Increase in Forest Inventory Cost	1% Increase in Forest Licencing Cost	1% Increase in Transportation Licencing Costs	1% Increase in Harvesting Costs	1% Increase in Dues & Refor Fees	1% Increase in Highway Tax	1% Increase in Road Building Cost	1% Increase in Scaling Cost	1% Increase in Admin Cost	1% Increase in Sort Yard Cost	1% Increase in Shipping Cost	1% Decrease in Utilization Rate	1% Decrease in Volume Harvested
Changing Cells:														
Forest Inv. Cost	0.773	0.781	0.773	0.773	0.773	0.773	0.773	0.773	0.773	0.773	0.773	0.773	0.773	0.781
Forest Lic. Cost	0.296	0.296	0.299	0.296	0.296	0.296	0.296	0.296	0.296	0.296	0.296	0.296	0.296	0.299
Trans. Lic. Cost	0.140	0.140	0.140	0.142	0.140	0.140	0.140	0.140	0.140	0.140	0.140	0.140	0.140	0.142
Harvesting Cost	38.250	38.250	38.250	38.250	38.633	38.250	38.250	38.250	38.250	38.250	38.250	38.250	38.250	38.250
Dues & Refor.	6.041	6.041	6.041	6.041	6.041	6.101	6.041	6.041	6.041	6.041	6.041	6.041	6.041	6.041
Highway Tax	2.500	2.500	2.500	2.500	2.500	2.500	2.525	2.500	2.500	2.500	2.500	2.500	2.500	2.500
Road Cost	2.000	2.000	2.000	2.000	2.000	2.000	2.000	2.020	2.000	2.000	2.000	2.000	2.000	2.000
Scaling Cost	0.125	0.125	0.125	0.125	0.125	0.125	0.125	0.125	0.127	0.125	0.125	0.125	0.125	0.126
Admin Cost	5.817	5.817	5.817	5.817	5.817	5.817	5.817	5.817	5.817	5.875	5.817	5.817	5.817	5.876
Sort Yard Cost	6.015	6.015	6.015	6.015	6.015	6.015	6.015	6.015	6.015	6.015	6.076	6.015	6.015	6.076
Shipping Cost	5.401	5.401	5.401	5.401	5.401	5.401	5.401	5.401	5.401	5.401	5.401	5.455	5.401	5.401
Utilization Rate	100.000	100.000	100.000	100.000	100.000	100.000	100.000	100.000	100.000	100.000	100.000	100.000	99.000	100.000
Result Cells:														
Effective Cost	67.360	67.367	67.363	67.361	67.742	67.420	67.385	67.380	67.361	67.418	67.420	67.414	68.040	67.492
% Change in Effective Cost		**0.0104%**	**0.0045%**	**0.0015%**	**0.5671%**	**0.0891%**	**0.0371%**	**0.0297%**	**0.0015%**	**0.0861%**	**0.0891%**	**0.0802%**	**1.0095%**	**0.1965%**

Changes in the utilization rates have the largest impact on the effective cost of fibre procurement in both the factual and counter-factual models. In the case of the factual model, a one percent change in the utilization rate results in a negatively correlated change in the effective cost of fibre procurement of 0.99%. The counter-factual model generates a slightly larger change in the effective cost of fibre procurement, with a negatively correlated change in the effective cost of one percent resulting from a one percent change in the utilization rate.

Table 5.8: IO Cooperative Average Cost Function Year 1 through Year 5 with 90% Utilization (all values in $ per m harvested)

	Year				
	1	**2**	**3**	**4**	**5**
Forest Inventory	0.77	0.74	0.74	0.74	0.75
Forest Licencing	0.30	0.15	0.10	0.08	0.06
Transport Licencing	0.14	0.07	0.05	0.04	0.03
Harvesting	38.25	38.56	38.87	39.19	39.52
Dues & Refor.	6.04	6.16	6.28	6.41	6.54
Highway Tax	2.50	2.55	2.60	2.65	2.71
Roads & Reclam.	2.00	2.04	2.08	2.12	2.16
Scaling	0.13	0.08	0.06	0.05	0.05
Co-op Admin	5.82	2.66	1.68	1.56	1.19
Sort Yard	6.02	4.98	4.43	4.33	4.16
Sort Yard to Mill Shipping	5.40	5.40	5.40	5.40	5.40
Gross Cost	67.36	63.21	61.96	62.06	61.86
Utilization Rate (%)*	90%	90%	90%	90%	90%
Effective Cost**	**74.84**	**70.23**	**68.84**	**68.95**	**68.74**

* Model operates under the assumption that the cooperative achieves 90% utilization through sorting and delivering specific fibre to the appropriate IO mill.

* Assume that fibre cannot be sold to external mills on a cost recovery basis

**Effective cost is measured as gross cost divided by utilization rate. This is the real cost for each unit of effective timber as you pay for all timber but can only utilize a portion in production.

The fact that a change in the utilization rate generates a negatively correlated one to one change in the effective cost of fibre procurement in both models means that fibre procurement costs and the potential cost reductions stemming from formation of an IO NGC are highly dependent on the utilization rate obtained. If, for example, the IO NGC is unable to sell residual fibre into the existing pulp and hog fuel market, the data obtained in the IO case study shows that the IO NGC will only be able to attain a utilization rate of 90%. Modelling counter-factual fibre procurement costs under a utilization rate of 90% (as shown in figure 5.9) reveals that the reductions to fibre procurement cost created by the IO NGC are significantly reduced. That being said, a utilization rate of 90% reveals that the effective of cost of fibre procurement is still lower than that observed in the factual model, albeit significantly lower than is the case with a 100% utilization rate. Finally, a breakeven analysis of the required utilization rate reveals that the breakeven utilization rate for the IO NGC is 83% in year one and slowly falls to 70% by year 5.

Table 5.9: Net Change in Average Cost Between Counterfactual (IO Cooperative) Model with 90% Utilization and Factual Model (values in $ per m harvested)*

	Year				
	1	2	3	4	5
Forest Inventory	- 0.09	- 0.14	- 0.16	- 0.17	- 0.18
Forest Licencing	- 0.39	- 0.55	- 0.61	- 0.65	- 0.68
Transport Licencing	- 0.18	- 0.26	- 0.29	- 0.31	- 0.32
Harvesting	- 4.49	- 5.04	- 5.60	- 6.17	- 6.75
Dues & Refor.	0.22	0.22	0.23	0.23	0.23
Highway Tax	-	-	-	-	-
Roads & Reclam.	0.15	0.16	0.16	0.16	0.17
Scaling	- 1.38	- 1.46	- 1.50	- 1.54	- 1.58
Admin	3.73	0.53	- 0.49	- 0.66	- 1.07
Sort Yard*	6.02	4.98	4.43	4.33	4.16
Sort Yard to Mill Shipping	5.40	5.40	5.40	5.40	5.40
Change in Gross Cost	8.99	3.67	1.23	0.11	- 1.32
Change in Utilization Rate (%)	18%	18%	18%	18%	18%
Change in Effective Cost	**- 6.23**	**- 12.46**	**- 15.51**	**- 17.08**	**- 19.02**

* Comparison Calculated by Subtracting Factual Model Values from Counterfactual Model Values to yield the net change in average cost realized by the Counterfactual Model

To analyze the stability of the cooperative model, additional sensitivity analysis was conducted to examine the effect of variances in the total volume of fibre harvested on the effective cost of fibre procurement. This variable was deemed to be of value as it mirrors the participation rate of IOs in the NGC and, thus, also reveals how variances in IO participation rates change the effective cost of fibre procurement and viability of the NGC. In both models, the effects of changes in the volume of fibre harvested were only marginally significant when compared to the effects of changes in utilization and direct harvesting costs. In the case of the factual model, a one percent decrease in the volume of fibre harvested would result in a 0.1% increase in the effective cost of fibre procurement, while for the counter-factual model a one percent decrease in the volume of fibre harvested increases the effective cost of fibre procurement by 0.2%.

While this latter result may appear significant, closer inspection reveals that it would require a major decrease in IO participation in the NGC to have a major impact on the effective cost of fibre procurement. For example, a reduction in the volume of fibre harvested by the IO NGC in year one from 40,439 cubic metres to 30,329 cubic metres represents a 25% overall reduction in the total volume of fibre harvested. Yet, this reduction in the total volume of fibre harvested only increases the effective cost of fibre procurement by 4.91%. When the effective cost of fibre procurement is increased by 4.91% the counterfactual model still generates reductions in the effective cost of fibre procurement of -12.09%. Thus, the cooperative could still provide net economic benefits to IOs if the participation rate was 25% lower than anticipated in year one.

Table 5.10: IO Cooperative Average Cost Function Year 1 through Year 5 with Breakeven Utilization Rate (all values in $ per m harvested)

	Year				
	1	2	3	4	5
Forest Inventory	0.77	0.74	0.74	0.74	0.75
Forest Licencing	0.30	0.15	0.10	0.08	0.06
Transport Licencing	0.14	0.07	0.05	0.04	0.03
Harvesting	38.25	38.56	38.87	39.19	39.52
Dues & Refor.	6.04	6.16	6.28	6.41	6.54
Highway Tax	2.50	2.55	2.60	2.65	2.71
Roads & Reclam.	2.00	2.04	2.08	2.12	2.16
Scaling	0.13	0.08	0.06	0.05	0.05
Co-op Admin	5.82	2.66	1.68	1.56	1.19
Sort Yard	6.02	4.98	4.43	4.33	4.16
Sort Yard to Mill Shipping	5.40	5.40	5.40	5.40	5.40
Gross Cost	67.36	63.21	61.96	62.06	61.86
Utilization Rate (%)*	83%	76%	73%	72%	70%
Effective Cost**	**81.08**	**82.70**	**84.35**	**86.04**	**87.76**

* Model operates under the assumption that the cooperative achieves breakeven utilization
**Effective cost is measured as gross cost divided by utilization rate. This is the real cost for each unit of effective timber as you pay for all timber but can only utilize a portion in production.

Overall, the results of the sensitivity and breakeven analysis reinforce the fact that as participation rates increase, utilization becomes slightly less important as scale effects take over. Despite this, utilization remains the most significant factor in the determination of the effective cost of fibre procurement. These results also suggest that harvesting cost stability is an important factor for IOs in the business as usual case and the IO NGC case. However, the IO NGC does provide producers with some reduction in the risks posed by harvesting costs fluctuations, as evidenced by the lower harvesting cost sensitivity value in the counter-factual model. The sensitivity analysis also suggests that, ceteris paribus, the IO NGC remains feasible and provides net economic benefits to IOs even at relatively low participation rates.

Table 5.11: Net Change in Average Cost Between Counterfactual (IO Cooperative) Model with Breakeven Utilization Rate and Factual Model (values in $ per m harvested)*

	Year				
	1	2	3	4	5
Forest Inventory	- 0.09	- 0.14	- 0.16	- 0.17	- 0.18
Forest Licencing	- 0.39	- 0.55	- 0.61	- 0.65	- 0.68
Transport Licencing	- 0.18	- 0.26	- 0.29	- 0.31	- 0.32
Harvesting	- 4.49	- 5.04	- 5.60	- 6.17	- 6.75
Dues & Refor.	0.22	0.22	0.23	0.23	0.23
Highway Tax	-	-	-	-	-
Roads & Reclam.	0.15	0.16	0.16	0.16	0.17
Scaling	- 1.38	- 1.46	- 1.50	- 1.54	- 1.58
Admin	3.73	0.53	- 0.49	- 0.66	- 1.07
Sort Yard*	6.02	4.98	4.43	4.33	4.16
Sort Yard to Mill Shipping	5.40	5.40	5.40	5.40	5.40
Change in Gross Cost	8.99	3.67	1.23	0.11	- 1.32
Change in Utilization Rate (%)	11%	4%	1%	0%	-2%
Change in Effective Cost	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**

* Comparison Calculated by Subtracting Factual Model Values from Counterfactual Model values to yield the net change in average cost realized by the Counterfactual Model

5.5 Implications

Counter to our initial hypothesis, the cooperative model's most significant economic benefits for IOs are not driven primarily by the creation of economies of scope in harvesting, nor are they driven by significant increases in purchasing power created through the marketing of larger harvest volumes. Instead, the most significant economic benefits are derived from large increases in fibre utilization and corresponding decreases in the effective cost of fibre procurement generated by economies of scope. This suggests that the high fibre specificity of IOs is a major source of inefficiency and that, in the absence of the IO NGC, may represent their greatest challenge. More specifically, the fibre specificity required to produce product lines generates a significant level of unutilized fibre from which IOs are unable to recover value. This in turn is having significant negative effects on the profitability and competitiveness of IOs. Moreover, small timber volumes make it impossible for them to rectify using conventional means such as the addition of product lines which employ underutilized fibre in their production or the resale of underutilized fibre to larger pulp and hog fuel markets. As such, IOs must work cooperatively to utilize the full timber profile. It is only by working together that IOs will be able to achieve economic benefits generated through full utilization. The incorporation of the log sort yard into the cooperative model, while costly, generates significant utilization and efficiency gains. From a policy perspective, the results imply that the pursuit of policies that reduce fibre procurement costs should be focused on policies that reduce direct harvesting costs, as this cost component is the greatest contributor to overall fibre procurement costs. Secondly, the results reveal that, when dealing with IOs, government should focus on policies that facilitate and promote cooperation among IOs; especially when that cooperation involves collective management and increased utilization of forest resources by IOs. This type of cooperation not only provides economic benefits for IOs but also to society in the form of reduced transaction costs for government and increased environmental benefits stemming from more efficient use of forest resources.

This research reveals that forest product mills that utilize residual fibre such as pulp mills, cogeneration plants, and value added product mills are important in maintaining a healthy and vibrant forest economy. These entities assist in ensuring that producers with high fibre specificity and high quality fibre needs are able to sell their residual product and achieve cost recovery on fibre that cannot be utilized in production processes. As such, policies that encourage the establishment and success of forest product mills that utilize residual fibre should be encouraged and enhanced.

In a broader context, this research also reveals that the cooperative model has the potential to provide small-scale forest producers with limited access to fibre and highly specific fibre needs with benefits beyond the creation of economies of scope, economies of scale, and reductions in transaction costs; such as increases in utilization. The increased utilization potential afforded to these types of producers under the cooperative model is a major source of economic efficiency gains that are not attainable in the absence of cooperation. Increasing utilization will undoubtedly become more important as rapidly expanding global demand puts more pressure on scarce natural resources.

The results of this research suggest that the cooperative model is effective in providing substantial economic benefits to individual IO firms. The level of benefits is marginally affected by the participation rate but mostly dependant upon the utilization rate and the harvesting costs or, in this case, the harvesting rates charged by contractors. The cooperative acts to enhance utilization rates by creating a situation in which timber allocations are pooled, collectively harvested, and then pre-sorted through the log sort yard. It is through sorting at the log sort yard and ensuring that mills receive only timber that meets their production specifications that utilization gains are achieved. As such, the log sort yard, while costly, is an essential component of an IO NGC.

The economic analysis in the study has shown that for full utilization, the gains coupled with reductions in harvesting costs reduce the effective cost of fibre by 12% to 30%, depending on the participation rate. When the utilization rate is reduced to 90%, the effective cost of fibre procurement is still reduced by between 8% and 22%, depending on the participation rate. Given that fibre represents the largest cost component of most forest products produced by IOs, substantial fibre cost reductions generated through cooperating could significantly increase profitability and ensure that those firms remain viable and competitive. As long as the IOs have the capacity and willingness to organize the NGC and perceive that the fibre cost reductions are worth the time investment and reduction in short-term control of harvesting operations, the NGC model has the potential to significantly improve the economic status of IO firms operating in the forest sector.

5.6 Limitations

As is the case with any academic work, there are certain limitations on the durability of this research. While this study has demonstrated that the NGC model has the potential to generate substantial increases in fibre utilization, thus reducing fibre procurement costs for forest producers, the nature of the benefits provided by the model limit its applicability. The NGC model will be most successful when utilized in situations where producers either have highly specific fibre needs or are operating in areas with low grade fibre. That is to say, the NGC model will provide limited benefits to producers whose utilization is already high. The results of this research also suggest that the NGC model may also prove to be a potentially useful tool anytime increased utilization of forest resources is the policy goal. With increasingly scarce resources and a growing population this will likely become a global forest policy objective in the near future.

The cost analysis presented in this study has clearly illustrates that policies aimed at reducing taxes, surcharges, and royalties (e.x. fuel taxes, highway taxes, timber royalties, etc.)

will have little impact on the cost effectiveness of small to medium sized producers. This is because these costs comprise such a small portion of IOs total fibre procurement costs and because IOs lack the economies of scope required to generate a significant level of cost savings on such small ticket items. The extension here is that policies aimed at improving economic outcomes for small to medium sized producers should focus on enhancing utilization potential and increasing economies of scope rather than providing subsidies and tax reductions.

Lastly, the NGC model can only be utilized by producers if the tenure and regulatory systems in the region allow for collective management of IO tenure allocation volumes at every point along the supply chain. Currently, many tenure regimes lack the flexibility required to immediately implement cooperative fibre procurement such as that suggested through the NGC model within this study. As such, the ability of producers to reorganize using the NGC model will, in many cases, be a function of the political will to restructure tenure and regulatory systems to allow for true collective management of natural resources.

5.7 Future Work

The concept of transaction costs in the forest sector have been rather understudied. This is especially true of the transaction costs incurred by the public sector. While it is true that some studies have eluded to the concept and one study has even suggested that as much as 75% of Saskatchewan's Forest Service Branch's operational staff is dedicated to working with IOs (Government of Saskatchewan, 2006), no study has attempted to derive an empirical estimate of transaction costs incurred by governmental bodies under various tenure structures with varying forms of producer organization. Such research could provide insight into the economic costs of the various forest tenure systems and forms of producer organization (e.x. the NGC model) and be utilized to guide developing nations who are only now constructing forest tenure systems in a landscape that often includes many small scale producers.

Forest cooperatives, particularly NGC's, may also have the potential to improve environmental outcomes by increasing overall fibre utilization. In a time when most countries are faced with a shrinking forest resource and increasing global demand for forest products, maximizing utilization of harvested fibre is becoming increasingly important. Further research should be conducted to examine the NGC model's effectiveness as a method of enhancing sustainable use of forest resources.

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Appendix A: Factual Model Background Data and Calculation Tables

Table A1: IO Producer PAFMA Harvest History (in m^3)

	PAFMA			
Year	**S1**	**S2**	**Undersize**	**Combined**
2007	17,449	14,258	323	32,030
2008	-	-	-	-
2009	3,054	4,582	799	8,435
07-09 Avg	**6,835**	**6,280**	**374**	**13,488**

Source Data: IO Financial Data, 2010.

Table A2: IO Producer Island Forest Harvest History (in m^3)

	Island Forest			
Year	**S1**	**S2**	**Undersize**	**Combined**
2007	6,936	1,733	-	8,670
2008	2,768	692	-	3,460
2009	-	-	-	-
07-09 Avg	**3,235**	**808**	**-**	**4,043**

Source Data: IO Financial Data, 2010.

Table A3: IO Producer Harvest History - All FMAs (in m^3)

Year	*Total - All FMAs*			
	S1	S2	Undersize	Combined
2007	24,385	15,991	323	40,700
2008	2,768	692	-	3,460
2009	3,054	4,582	799	8,435
07-09 Avg	**10,069**	**7,088**	**374**	**17,532**

Source Data: IO Financial Data, 2010.

Table A4: IO Timber cruising Costs 2007-2009 (in $)

Year	Aerial Survey	Labour	Forestry Supplies	Travel	Total Cost	* Total Cost per m^3
2007	-	35,455.00	3,821.16	5,000.00	44,276.16	**1.11**
2008	1,072.19	23,463.96	562.38	5,000.00	30,098.53	**0.75**
2009	1,072.19	22,755.00	-	5,000.00	28,827.19	**0.72**
07-09 Avg	**714.79**	**27,224.65**	**1,461.18**	**5,000.00**	**34,400.63**	**0.86**

* 40,000 m3 surveyed per year during 2007, 2008, and 2009.

Source Data: IO Financial Data, 2010.

Table A5: Average IO Forest Licencing Cost Calculation

Activity	Labour Hrs	Labour Cost ($)
Annual Operating Plan Development		
GIS Development	20	567.32
Document Development	80	2,269.28
Total AOP Development Cost		**2,836.61**
Negotiation Costs*		
Discussions with SERM	8	317.70
Revisions	4	158.85
Signing	4	158.85
Total AOP Negotiation Cost		**635.40**
Reporting Costs		
Cutover Summary	40	1,134.64
GIS Development	20	567.32
Wood Flow Summary	80	2,269.28
Total AOP Reporting Cost		**3,971.25**
Enforcement Costs		
Self-Audit	80	2,269.28
Government Inspection	40	1,134.64
Government Interaction	40	1,134.64
Total AOP Enforcement Cost		**4,538.57**
Total Forest Licencing Cost	**416**	**11,981.82**
Average Cost of Forest Licencing**		**0.68**

* Labour Costs associated with negotiation costs are costed at the management wage rate, all other labour costs are costed at the forester wage rate.

**Average Cost of Forest Licencing calculated using an average 2007-2009 harvest volume of 17531.54

Source Data: IO Financial Data, 2010.

Table A6: Harvesting Cost Matrix 2007-2009 (in $)

	Tree-length Converted to Shortwood					Shortwood
Year	Delivered Treelength	Bucking Cost	Loader and Equipment Cost	Manufactured Shortwood Price		Delivered Shortwood
2007	32.92	8.27	1.20	42.39		30.49
2008	36.21	8.27	1.20	45.69		36.36
2009	0.00	0.00	0.00	0.00		44.82

Source Data: IO Financial Data, 2010.

Table A7: Harvesting Composition Matrix

Year	Total Harvest Vol. (in m^3)	% Harvest-Treelength	% Harvest-Cut to Length	Treelength Harvest Vol. (in m^3)	Cut to Length Vol. (in m^3)
2007	40,699.85	82%	18%	33239.56	7460.28
2008	3,459.76	20%	80%	691.95	2767.81
2009	8,435.00	0%	100%	0.00	8435.00
07-09 Avg	**17,531.54**	**34%**	**66%**	**11310.51**	**6221.03**

Source Data: IO Financial Data, 2010.

Table A8: IO Blended Harvesting Costs (in $)

Year	Converted Shortwood Costs	Delivered Shortwood Costs	Total Harvesting Cost	Blended Harvesting Cost per m^3
2007	1,409,137.65	227,463.99	1,636,601.64	40.21
2008	31,612.09	100,637.50	132,249.59	38.23
2009	-	378,056.70	378,056.70	44.82
07-09 Avg	**480,249.91**	**235,386.06**	**715,635.98**	**41.09**

Source Data: IO Financial Data, 2010.

Table A9: IO Crown Dues and Reforestation Costs 2007-2009 (in $)

	PAFMA			*Island Forest*			All FMAs	
Year	S1 Dues & Refor.	S2 Dues & Refor.	Combined Cost	S1 Dues & Refor.	S2 Dues & Refor.	Combined Cost	Total Cost	Cost/ m^3
2007	113,419	74,854	188,274	23,289	4,810	28,099	216,373	5.32
2008	-	-	-	19,929	4,116	24,045	24,045	6.95
2009	19,853	24,055	43,908	-	-	-	43,908	5.21
07-09 Avg	**44,424**	**32,969**	**77,394**	**14,406**	**2,975**	**17,381**	**94,775**	**5.82**

Source Data: IO Financial Data, 2010.

Table A10: SK Crown Dues and Reforestation Rates (in $)

Crown Dues					Reforestation Rates	
Year	Quarter	S1 Rate	S2 Rate		PAFMA	Island Forest
2007	Q1	2.00	0.75		4.50	5.200
	Q2	2.00	0.75		4.50	5.200
	Q3	2.00	0.75		4.50	5.200
	Q4	2.00	0.75		4.50	5.200
2008	Q1	2.00	0.75		4.50	5.200
	Q2	2.00	0.75		4.50	5.200
	Q3	2.00	0.75		4.50	5.200
	Q4	2.00	0.75		4.50	5.200
2009	Q1	2.00	0.75		4.50	5.200
	Q2	2.00	0.75		4.50	5.200
	Q3	2.00	0.75		4.50	5.200
	Q4	2.00	0.75		4.50	5.200
3 Year Average		**2.00**	**0.75**		**4.50**	**5.20**

Source Data: IO Financial Data, 2010.

Table A11: IO Incremental Asphalt Fee Highway Tax

Year	Incremental Asphalt Fees ($/m3)
2007	$ 1.50
2008	$ 2.00
2009	$ 4.00
07-09 Average	**$ 2.50**

Source Data: IO Financial Data, 2010.

Table A12: IO Scaling Costs 2007-2009 (in $)

Year	Total Scaling Costs		Scaling Cost per m3 Harvested
2007	45356.06		1.11
2008	8533.52		2.47
2009	7794.32		0.92
07-09 Avg	**20561.3**		**1.50**

Source Data: IO Financial Data, 2010.

Table A13: IO Road Building and Reclamation Costs

Year	Total Road Building/ Reclamation Costs	Road Building/ Reclamation Cost/m^3
2007	$ 28,911.48	$ 0.71
2008	$ 10,373.00	$ 3.00
2009	$ 15,457.00	$ 1.83
07-09 Avg	**$ 18,247.16**	**$ 1.85**

Source Data: IO Financial Data, 2010.

Table A14: IO Fibre Utilization Rates

Year	Wrong Species	Undersize	Oversize	Poor Quality	Total Unutilized Fibre	Utilization Rate
2007	3%	1%	20%	15%	39%	61%
2008	2%	0%	15%	10%	27%	73%
2009	1%	2%	10%	5%	18%	82%
07-09 AVG	**2%**	**1%**	**15%**	**10%**	**28%**	**72%**

Source Data: IO Financial Data, 2010.

Table A15: IO Labour Wage Rates 2007-2009

Senior Manager Wages

Wage	35.000	/Hr
CPP	0.866	/Hr
EI	0.490	/Hr
Vacation	2.019	/Hr
WCB	1.337	/Hr
	39.712	**/Hr**

Forester Wages

Wage	25.000	/Hr
CPP	0.619	/Hr
EI	0.350	/Hr
Vacation	1.442	/Hr
WCB	0.955	/Hr
	28.366	**/Hr**

Admin Assistant Wages

Wage	25.000	/Hr
CPP	0.619	/Hr
EI	0.350	/Hr
Vacation	1.442	/Hr
WCB	0.955	/Hr
	28.366	**/Hr**

Source Data: IO Financial Data, 2010.

Appendix B: Counterfactual Model Background Data and Calculation Tables

Table B1: IO NGC Softwood Allocation Volume (in m^3)

	PAFMA			Island Forest			Total - All FMAs		
Year	**S1**	**S2**	**Total**	**S1**	**S2**	**Total**	**S1**	**S2**	**Total**
1	73,215	76,785	150,000	25,476	26,719	52,195	98,691	103,504	**202,195**
2	73,215	76,785	150,000	25,476	26,719	52,195	98,691	103,504	**202,195**
3	73,215	76,785	150,000	25,476	26,719	52,195	98,691	103,504	**202,195**
4	73,215	76,785	150,000	25,476	26,719	52,195	98,691	103,504	**202,195**
5	73,215	76,785	150,000	25,476	26,719	52,195	98,691	103,504	**202,195**

Source Data: Saskatchewan Ministry of Environment, 2010.

Table B2: IO NGC Softwood Harvest Volume (in m^3)

	PAFMA			Island Forest			Total - All FMAs		
Year	**S1**	**S2**	**Total**	**S1**	**S2**	**Total**	**S1**	**S2**	**Total**
1	14,643	15,357	30,000	5,095	5,344	10,439	19,738	20,701	**40,439**
2	29,286	30,714	60,000	10,191	10,687	20,878	39,477	41,401	**80,878**
3	43,929	46,071	90,000	15,286	16,031	31,317	59,215	62,102	**121,317**
4	58,572	61,428	120,000	20,381	21,375	41,756	78,953	82,803	**161,756**
5	73,215	76,785	150,000	25,476	26,719	52,195	98,691	103,504	**202,195**

Table B3: IO NGC Harvest Summary Table

Year	Total Harvest Vol. (m^3)	Average Block Vol. (m^3)	No. Blocks Harvested
1	40,439	20,220	2
2	80,878	20,220	4
3	121,317	20,220	6
4	161,756	20,220	8
5	202,195	20,220	10

Table B4: IO NGC Forest Inventory Costs

Year	Aerial Survey	Ground Recon.	Sampling	Forestry Supplies*	Travel Cost	Total Cost	Cost Per m3 Harvested
1	3,913.01	10,749.92	12,541.57	1,010.98	3,044.09	31,259.57	**0.77**
2	3,991.27	21,929.83	25,584.81	2,021.95	6,209.95	59,737.81	**0.74**
3	4,071.09	33,552.65	39,144.75	3,032.93	9,501.23	89,302.65	**0.74**
4	4,152.52	45,631.60	53,236.87	4,043.90	12,921.67	119,986.55	**0.74**
5	4,235.57	58,180.29	67,877.00	5,054.88	16,475.13	151,822.86	**0.75**

*Allow $0.25 per m3 sampled for forestry supplies
Source Data: IO Historical Operations Data, 2010.

Table B5: IO NGC Forest Inventory Travel Costs

Average Trip Distance	**320**	**km (return)**
Mileage Rate	**$ 0.38**	**/km**
Average Trip Cost	**$ 121.60**	**/Trip**

Source Data: IO Historical Operations Data, 2010.

Table B6: IO NGC Forest Inventory Sampling Costs

Activity	Labour Hrs/Trip	Cost/trip
Sample Planning Labour	5	$ 232.60
Sampling Labour	10	$ 465.20
Post Sampling Labour	5	$ 232.60
Total	**20**	**$ 930.41**

Source Data: IO Historical Operations Data, 2010.

Table B7: IO NGC Ground Reconnaissance Survey Costs

Activity	Labour Hrs/Trip	Cost/trip
Survey Planning Labour	5	$ 232.60
Survey Labour	10	$ 465.20
Post Survey Labour	5	$ 232.60
Total	**20**	**$ 930.41**

Source Data: IO Historical Operations Data, 2010.

Table B8: IO NGC Aerial Survey Costs

Activity	Labour Hrs/Trip	Cost
Aircraft Rental	**-**	**$ 5,500.00**
Survey Planning Labour	**20**	**$ 930.41**
Survey Labour	**10**	**$ 465.20**
Post Survey Labour	**20**	**$ 930.41**
Total	**50**	**$ 7,826.02**

* One Aerial Survey Every Two Years
Source Data: IO Historical Operations Data, 2010.

Table B9: IO NGC Forest Inventory Productivity Data

Cruise Productivity	**700.00**	**m^3 per hour**
Sampling Ratio	**5%**	
Sample Plot Size	**0.04**	**hectare**
Sampling Productivity	**5.00**	**hrs/sample**
Avg Stand Productivity	**150.00**	**m^3 per hectare**

Source Data: IO Historical Operations Data, 2010.

Table B10:Counterfactual Model Forest Inventory Background Information

Year	M^3 Surveyed*	M^3 Sampled**	No. Of Sample Plots	No. of Timbercruise Trips	No. Sampling Trips	Total No. Trips
1	80,878	4,044	27	12	13	25
2	161,756	8,088	54	23	27	50
3	242,634	12,132	81	35	40	75
4	323,512	16,176	108	46	54	100
5	404,390	20,220	135	58	67	125

* Survey 200% Annual harvest to allow for 50% rejection rate.
** Sampling Ratio of 5% employed.

Table B11: IO NGC Forest Licencing Costs*

Year	AOP Development	AOP Negotiation Cost	AOP Reporting Cost	AOP Enforcement Cost	Total Forest Licencing Cost	Harvest Vol.	Cost per m3
1	$ 2,836.61	$ 635.40	$ 3,971.25	$ 4,538.57	$ 11,981.82	40439	**$ 0.30**
2	$ 2,893.34	$ 648.11	$ 4,050.67	$ 4,629.34	$ 12,221.46	80878	**$ 0.15**
3	$ 2,951.20	$ 661.07	$ 4,131.69	$ 4,721.93	$ 12,465.89	121317	**$ 0.10**
4	$ 3,010.23	$ 674.29	$ 4,214.32	$ 4,816.37	$ 12,715.21	161756	**$ 0.08**
5	$ 3,070.43	$ 687.78	$ 4,298.61	$ 4,912.69	$ 12,969.51	202195	**$ 0.06**

*Forest licencing costs are equal to those incurred under the factual individual producer model. The only variable which changes is the harvest volume applied for under the licence.

Table B12: IO NGC Transportation Licencing Costs

Year	Partnership Agreement Development	Partnership Agreement Negotiation Cost	PA Reporting Cost	Total Transportation Licencing Costs	Harvest Vol.	Cost per m3
1	$ 658.09	$ 476.55	$,538.57	$ 5,673.21	40,439	$ 0.14
2	$ 671.25	$ 486.08	$4,629.34	$ 5,786.68	80,878	$ 0.07
3	$ 684.68	$ 495.80	$,721.93	$ 5,902.41	121,317	$ 0.05
4	$ 698.37	$ 505.72	$,816.37	$ 6,020.46	161,756	$ 0.04
5	$ 712.34	$ 515.83	$4,912.69	$ 6,140.87	202,195	$ 0.03

*Transportation licencing costs are equal to those incurred under the factual individual producer model. The only variable that changes is the harvest volume applied for under the licence.

Table B13: Current Timber Harvesting Market Prices

Activity	$/tonne	$/m3
Timber Harvesting	$ 19.38	$ 22.85
Log Loading	$ 1.73	$ 2.04
Hauling	$ 11.32	$ 13.35
Total Cost	**$ 32.44**	**$ 38.25**

* Rates Based on a hauling rate of $135/hr, a round trip of 320km per hour, an average speed of 90km per hour, an 1 hr/trip allowance for loading and unloading, and a 47m3 payload.

Source Data: Eagle Creek Contracting, 2010. Norrish Logging, 2010.

Table B14: IO NGC Delivered Treelength Costs 2011-2015

Year	Treelength Harvesting	Log Loading	Treelength Hauling	Total Cost	Average Cost per m^3
1	$924,183.75	$82,690.13	$539,933.44	$1,546,807.32	$ 38.25
2	$1,848,367.50	$168,687.86	$1,101,464.22	$3,118,519.57	$ 38.56
3	$2,772,551.25	$258,092.42	$1,685,240.25	$4,715,883.92	$ 38.87
4	$3,696,735.00	$351,005.69	$2,291,926.74	$6,339,667.43	$ 39.19
5	$4,620,918.75	$447,532.25	$2,922,206.60	$7,990,657.60	$ 39.52

Table B15: IO NGC Softwood Dues and Reforestation Costs: Year 1 through Year 5

	PAFMA			Island Forest			Total - All FMAs	
Year	S1 Dues & Refor.	S2 Dues & Refor.	Combined Cost	S1 Dues & Refor.	S2 Dues & Refor.	Combined Cost	Total Cost	Cost per m3
1	95,180	80,624	175,804	36,686	31,795	68,481	**244,285**	**6.04**
2	190,359	161,249	351,608	73,372	63,590	136,962	**488,570**	**6.04**
3	285,539	241,873	527,411	110,058	95,385	205,443	**732,855**	**6.04**
4	380,718	322,497	703,215	146,744	127,181	273,925	**977,140**	**6.04**
5	475,898	403,121	879,019	183,430	158,976	342,406	**1,221,424**	**6.04**

*Operates under the assumption that crown dues and reforestation fees remain at the 07-09 3 year average for the next 5 years.

Table B16: IO NGC Scaling Background Data

Weigh Scale Capital Cost	
Equipment Cost	$ 15,000.00
Installation Cost	$ 15,000.00
Total Cost	$ 30,000.00
Amortization period	10 Years
Interest Rate	4.45%
Annual Equip. Cost	$ 3,722.28
Annual R&M Cost	$ 372.23
Total Annual Cost	**$ 4,094.51**

Source Data: Massload, 2010.
CRA, 2010. Bank of Canada, 2011.

Forester Wage Cost		
Wage	25.00	/Hr
CPP	0.62	/Hr
EI	0.35	/Hr
Vacation	1.44	/Hr
WCB	0.96	/Hr
	28.366	**/Hr**

Source Data: IO Financial Data, 2010. CRA, 2010.

Sample Scale Frequency	**1.00%**	
Sample Scale Scaler Productivity	**11.75**	**m3/hr**

Source Data: MOE Forest Service Branch, 2010.
IO Historical Forestry Data, 2010.

Table B17: IO NGC Sample Scaling Labour Cost Calculation

Year	Total Harvest (m^3)	Sample Scale Volume (m3)	Scaler Labour Hrs	Scaler Labour Cost
1	40,439.00	404.39	34.42	$ 976.25
2	80,878.00	808.78	68.83	$ 1,991.55
3	121,317.00	1,213.17	103.25	$ 3,047.07
4	161,756.00	1,617.56	137.66	$ 4,144.02
5	202,195.00	2,021.95	172.08	$ 5,283.63

Table B18: IO NGC Scaling Cost

Year	Total Harvest (m^3)	Scaler Labour Cost	Weigh Scale Cost	Total Scaling Cost	Scaling Cost per m3
1	40,439.00	$ 976.25	$ 4,094.51	$ 5,070.76	**$ 0.13**
2	80,878.00	$ 1,991.55	$ 4,094.51	$ 6,086.06	**$ 0.08**
3	121,317.00	$ 3,047.07	$ 4,094.51	$ 7,141.58	**$ 0.06**
4	161,756.00	$ 4,144.02	$ 4,094.51	$ 8,238.53	**$ 0.05**
5	202,195.00	$ 5,283.63	$ 4,094.51	$ 9,378.14	**$ 0.05**

Table B19: IO NGC Road Building and Reclamation Costs

Year	Total Harvest (m^3)	Road Building & Reclamation Cost ($/m3)
1	40,439.00	**$ 2.00**
2	80,878.00	**$ 2.04**
3	121,317.00	**$ 2.08**
4	161,756.00	**$ 2.12**
5	202,195.00	**$ 2.16**

*Assume Rate is set at $2.00 per m3 in Year 1 and rises at the rate of inflation (2%)

Table B20: Forecasted Administrative Expenses: Year 1 through Year 5

Item	Year 1	Year 2	Year 3	Year 4	Year 5
Accounting and Legal	20,000.00	10,000.00	10,200.00	10,404.00	10,612.08
Insurance	35,000.00	35,700.00	36,414.00	37,142.28	37,885.13
Telephone/Internet	6,000.00	6,120.00	6,242.40	6,367.25	6,494.59
Office Supplies	6,000.00	6,120.00	6,242.40	6,367.25	6,494.59
Photocopier	1,800.00	1,836.00	1,872.72	1,910.17	1,948.38
Computers/Equipment	2,400.00	2,448.00	2,496.96	2,546.90	2,597.84
Wages and Salaries	152,042.07	140,616.22	128,082.28	174,593.27	161,504.79
Total	**223,242.07**	**202,840.22**	**191,550.76**	**239,331.12**	**227,537.40**

*Accounting and Legal Costs higher in year one to account for incorporation, etc.

*Assumption: Rate of inflation of 2% per annum

* Administration expenses are fixed and will not increase as the volume of timber managed by the cooperative increases

Source Data: IO Financial Data, 2010.

Table B21: Administration Expense per Cubic Metre Harvested

Year	Total Harvest (m^3)	Admin. Exp ($/$m^3$)
1	40,439.00	$5.82
2	80,878.00	$2.66
3	121,317.00	$1.68
4	161,756.00	$1.56
5	202,195.00	$1.19

Table B22: Log Sort Yard Background - Labour Rates

Loader Operator Wage		
Wage	20.000	/Hr
CPP	0.495	/Hr
EI	0.280	/Hr
Vacation	1.154	/Hr
WCB	0.764	/Hr
	22.693	**/Hr**

Yard Foreman Wage		
Wage	27.000	/Hr
CPP	0.668	/Hr
EI	0.378	/Hr
Vacation	1.558	/Hr
WCB	1.031	/Hr
	30.635	**/Hr**

Annual Productive Hours	**2000**

Source Data: IO Financial Data, 2010.

Table B23: Log Sort Yard Capital Costs

Site Development Capital Cost		
Item	**Value**	**Data Source**
Land Cost	$ 70,000.00	IO Financial Data, 2010.
Site Preparation Costs	$ 45,000.00	IO Financial Data, 2010.
Maintenance Building Cost	$ 140,000.00	IO Financial Data, 2010.
ATCO Office Trailer Cost	$ 30,000.00	www.kijiji.ca
Total Cost	**$ 85,000.00**	
Interest Rate	4.45%	Bank of Canada, 2011.
Amortization period	20 Years	CRA, 2010.
Annual Cost	**$ 21,544.44**	

Slasher Capital Cost		
Item	**Value**	**Source**
Equipment Cost	$ 68,242.00	www.forestryequipment sales.com
Amortization Period	5 Years	CRA, 2010.
Interest Rate	4.45%	Bank of Canada, 2011.
Annual Cost	**$ 15,248.28**	**Per Slasher**

Loader Capital Cost		
Item	**Value**	**Source**
Equipment Cost	$ 95,000.00	IO Financial Data, 2010.
Amortization period	5 Years	CRA, 2010.
Interest Rate	4.45%	Bank of Canada, 2011.
Annual Cost	**$ 21,227.16**	**Per Loader**

Table B24: Log Sort Yard Productivity Data

Loader Productivity*		
Unloading Treelength	94	m^3 per hour
Loading Shortwood	90	m^3 per hour
Servicing Slasher	115	m^3 per hour

Slasher Productivity**		
Volume Slashed	20.385	m^3 per hour

* Loader productivity values account for 10% down time.

** Slasher productivity values account for 10% down time.
Source Data: IO Historical Operations Data, 2010.

Table B25: Log Sort Yard - Loader Requirements

Year	Fibre Volume Handled	Loader Hrs Required - Unloading	Loader Hrs Required - Loading	Loader Hrs Required - Slasher	Total Loader Hours Required	No. Of Loaders Required
1	40,439	430	449	352	1,231	1
2	80,878	860	899	703	2,462	1.25
3	121,317	1,291	1,348	1,055	3,694	2
4	161,756	1,721	1,797	1,407	4,925	2.5
5	202,195	2,151	2,247	1,758	6,156	3

Table B26: Log Sort Yard - Slasher Requirements

Year	Fibre Volume Handled	Total Slasher Hrs Required	No. of Slashers Required
1	40,439	1,984	1
2	80,878	3,968	2
3	121,317	5,951	3
4	161,756	7,935	4
5	202,195	9,919	5

Table B27: Average Sort Yard to Mill Haul Distance Calculation

Timber Class	Shipping Area	% of Total Allocation Shipped to Area[Ɨ]	Average Shipping Distance to Area (in km)	Contribution to Average Overall Haul Distance (km)
S2	PA NORTH (S2 MILLS)*	51%	22.95	11.75
S1	PA NORTH (S1 MILLS)**	5%	57.6	2.81
S1	PA SOUTH (S1 MILLS)***	9%	48.95	4.18
S1	PA WEST (S1 MILLS)****	11%	152.5	16.75
S1	PA EAST (S1 MILLS)*****	24%	115	28.07
		Average Overall Shipping Distance (one-way in km)		**63.55**

*PA NORTH (S2 MILLS) shipping area average distance is based on sending products to Meath Park, Spruce Home, and Redwing.

**PA NORTH (S1 MILLS) shipping area average distance is based on sending products to the Lakeland Region.

***PA SOUTH (S1 MILLS) is based on sending products to Lily Plain and Rosthern.

****PA WEST (S1 MILLS) is based on sending products to Big River and Leoville.

*****PA EAST (S1 MILLS) shipping area average distance is based on sending products to Love, Choiceland, and Whitefox

[Ɨ] Values based on mill locations and allocations provided by Saskatchewan Forest Service Branch.

Table B28: Sort Yard to Mill Hauling Cost Calculation

Item	Value	Units
Average Haul Distance (return)	127.11	km
Average Haul Speed	90	km/hr
Average Haul Time (Loading inc.)	2.41	hr
Trucking Cost per Hr	150	$/hr
Haul Cost per Load	361.85	$/load

Table B29: Sort yard to Mill Hauling Costs: Year 1 through Year 5*

Year	Volume Harvested	Average Volume per Load	Total No. of Loads	Cost per Load	Total Cost	Cost/m3
1	40,439.00	67	604	$361.85	$ 218,399.63	**$ 5.40**
2	80,878.00	67	1,207	$361.85	$ 436,799.26	**$ 5.40**
3	121,317.00	67	1,811	$361.85	$ 655,198.89	**$ 5.40**
4	161,756.00	67	2,414	$361.85	$ 873,598.52	**$ 5.40**
5	202,195.00	67	3,018	$361.85	$1,091,998.15	**$ 5.40**

* Operating under the assumption that all products harvested within the year will be removed from the log sort yard and shipped to various IO mills.

*Operating under the assumption that all volume produced will go to IO mills with PAFMA allocations.

*In the event that assumption 2 does not hold, all fibre sold to external mills will be sold, at a minimum, on a 100% cost recovery basis.

Table B30: IO NGC Log Sort Yard Operations Costs (in $)

Year	Mortgage	Loader Capital Cost	Slasher Capital Cost	R & M*	Fuel Cost	Loader Labour Cost	Slasher Labour Cost	Foreman Labour Cost	Total Cost	Average Cost ($/m^3)
1	21,544	21,227	15,248	11,604	39,409	27,939	45,017	61,271	243,260	**6.02**
2	21,544	42,454	30,497	18,899	78,817	55,877	91,835	62,496	402,422	**4.98**
3	21,544	42,454	45,745	21,949	118,226	83,816	140,508	63,746	537,991	**4.43**
4	21,544	63,681	60,993	29,244	157,634	111,755	191,091	65,021	700,968	**4.33**
5	21,544	63,681	76,241	32,293	197,043	139,694	243,640	66,321	840,464	**4.16**

* Repair and Maintenance calculated as 20% of Annual Equipment Cost

APPENDIX C: SECONDARY DISCUSSION:

Modeling the Multiple Cruise Effect and the Potential Benefits of Cooperative Timber Cruising Among Saskatchewan's Independent Operators

Introduction

The independent operators (IOs) are small forest operators with timber allocation volumes in Saskatchewan forests below 15,000 m^3. As may be expected, this group is characterized by above-industry average wood procurement costs and transaction costs. The intuitive reasons for this are related to economies of scale. In the past, IO's above average costs were not a problem because market prices were above average for their products and they faced limited competition within markets. In recent years however, forest product markets have become increasingly competitive which has been confounded by low demand and low prices. Additionally, operating costs have risen faster than inflation because of higher fuel and energy costs. As such, there is a need to restructure operations to reduce costs and increase IO's competitiveness.

In earlier works, I have hypothesized that the best way for the IO's to reduce their costs is through the formation of a cooperative. This will not only create economies of scope for the IO's but will also allow for the elimination of the competitive inefficiencies that exist within the industry; this will have the effect of further reducing the IO's production costs. Wood procurement costs make up a substantial proportion of the average IO's total costs (Vermette, 2007). Timber cruising is the first step and thus the first cost incurred in the timber procurement process. It could be argued that timber cruising is the most important part of the timber procurement process as it determines the quantity, quality and proximity to the mill of the wood that will be harvested by the firm. Currently, the IO's competitively timber cruise stands within the same geographical area and do not share the results of their research. A common result is that the firms end up cruising the same stands and all coming to the same no harvest conclusion. This results in both firm and industry timber cruising costs which are much higher than they would be in the presence of information sharing between the firms. I have coined this "the multiple cruise effect".

This paper begins by providing background into the current situation and then provides a framework for the timber cruising cost model under the current system. In the sections that follow I provide a counterfactual situation in which information sharing is present and derive a timber cruising cost model for that situation. Finally, I explore the efficiency gains obtainable through cooperative timber cruising.

Background

Saskatchewan's IOs are required to operate within the predefined boundaries of the pre-existing Forest Management Agreement (FMA) Areas to which their forest product permits (FPPs) are assigned. FMAs are 20 year tenure agreements formed between the provincial government and large forest producers that operate large pulp and paper mills or sawmills within the Province. There are five FMA's within Saskatchewan's commercial forest area. The IOs involved in this study all hold allocations within the Prince Albert FMA, which is held by Domtar who co-owns the Prince Albert Pulp and Paper Mill with the provincial government.

The FMA is located in the lower portion of the boreal forest and consists primarily of White Poplar (*Populus alba*), Black Poplar (*Populus nigra*), White Spruce (*Picea glauca*), Black Spruce (*Picea mariana*), and Jack Pine (*Pinus banksiana*). The latter of these species is by far the most highly demanded by forest product producers in the province; this is due to the fact that it is the softest timber, which also makes it the most sawable, formable, and the best suited for pulp and paper production. The FMA contains a high volume of Jack Pine (Pinus banksiana) but decades of large scale timber harvesting and the advance of Dwarf Mistletoe (Arceuthobium americanum) in the southern portions of the FMA, have significantly depleted easy access, low-cost harvestable timber in the southern most portion of the FMA. Of course these areas have been reforested but given that many of these Pinus banksiana stands are in the very early seral stages of growth (5 to 20 years old) and that the majority of the forest producers harvest Pinus banksiana stands that are 70 to 90 years old, these areas will not be available for commercial production for a couple of generations. Most of the remaining merchantable timber within the FMA lies in areas within the southern portion of the FMA that have limited access as a result of poor road development and wet or unstable summer ground conditions and the northern portion of the PAFMA which, in general, has limited access as a result of poor road development and sheer distance from the processing mills. This situation has increased the cost of fibre to the mills and thus created a greater incentive for firms to engage in timber cruising activities aimed at locating the lowest cost timber.

Timber cruising is conducted by foresters who begin by analyzing GIS data obtained from the Saskatchewan Forest Inventory Database. When analyzing the GIS data the forester selects focus areas with large stands of the target species that are within the target age range for the mills raw timber requirements. Since road building costs can make up a significant portion of the timber costs, stands that are in close proximity to existing roadways are favoured (Gunn and Richards, 2000). Hauling costs also make up a considerable proportion of timber procurement costs and as such target areas that are in closer proximity to the mill site are also favoured (Vermette, 2007). Once target areas have been defined, the areas are scheduled to be "cruised" by the firm's foresters. In the case of remote areas that are located more than several kilometres from an existing roadway an initial aerial survey, which may consist of random ground drops to allow the foresters to perform small scale sampling, is conducted to determine if there is sufficient timber potential to warrant full scale ground reconnaissance. In the case of areas that are less than a few kilometres away from a pre-existing roadway the aerial survey is generally skipped and the forester proceeds to direct ground reconnaissance. During ground reconnaissance a field crew constructs random sample plots and assesses the trees within the plots to determine the stands qualitative and quantitative properties, with the most important of these properties being the percentage of utilizable wood in the stand and the stand density.

Timber cruising can decrease the cost of wood by providing qualitative increases, quantitative increases, and proximity gains. Qualitative increases result from the discovery of stands that have higher utilization values than the majority of stands currently being targeted by a firm. Higher utilization decreases real input costs by increasing the quantity of finished product, and in some cases the grade of finished product, produced with each unit of input. For example, a firm pays $50 per cubic metre for timber and of that cubic metre thirty percent is waste wood that will be discarded and seventy percent is useable wood that will be used in production. The real cost of timber is actually equal to the price paid divided by the utilization percentage, which in this case is equal to $71.43 per cubic metre. Thus any increase in the utilization percentage that results from actively seeking better quality wood results in a real price for the timber input which is closer to the actual price paid for the timber (a cost savings). In the case of an increased grade, i.e. finding timber that produces grade "A" lumber instead of grade "B" lumber, the qualitative increase is realized by the firm in the form of an additional price premium received for the higher grade end product.

Quantitative increases result when the firm finds stands that have a higher density or yield than the majority of the stands that they are currently targeting. Targeting higher yield stands has the effect of reducing costs such as road building costs and camp costs, assuming that the stands are of equal size and distance from existing road infrastructure as the lower yield stands currently harvested. For example, assume we have two stands that are equal in area and in distance from the pre-existing roadway and that we will need to establish a camp at each stand during the harvest period and then remove it when harvesting has been completed. The cost of road building to access each of the stands is $20,000 and the camp costs associated with each stand are $10,000. Stand one has a total area of 100 hectares, a stand density of 100m^3/ha, and thus a total yield of 10,000m^3. Stand two has a total area of 100 hectares, a stand density of 150m^3/ha and thus a total yield of 15,000m^3. The resulting cost per cubic metre for road building and camp costs for stand one are three dollars per cubic metre and the same costs for stand two are two dollars per cubic metre. Thus, quantitative increases can result in substantial decreases in access costs and camp costs.

Proximity gains are achieved by finding harvestable timber as close as possible to the mill site. This has the effect of significantly reducing the transportation costs that make up approximately 25% of the raw timber costs for the average medium sized mill (Vermette, 2007). Harvesting timber in close proximity to the mill provides some additional less tangible benefits to the mill including the ability to more effectively manage the harvesting site, as it is easier for upper management, production yard quality control personnel, specialized equipment mechanics, and supply delivery personnel to make regular day trips to sites that are a short haul away versus sites that are located a considerable distance from the mill. In the past few years proximity gains have been one of the central goals of the IOs and many of the firms have invested considerable resources timber cruising for merchantable timber in the southern portion of the FMA, this has been growing in both incidence and intensity as the increase in fuel prices (which make up a large portion of the heavily mechanized activity of timber harvesting and hauling) has brought the imaginary line ,within which timber harvesting and hauling at that distance is feasible, ever closer to the production mills. This has had the effect of concentrating the timber cruising efforts of the firms into a relatively small geographical area.

Concentrating timber cruising efforts of the IO's into a small geographical area would not be an issue if the firms shared the results of their timber cruises, but at the current time they do not. This reluctance to share information stems from the fact that the firms all demand timber that is within the same species and age class. As such, any low cost timber harvested by another firm reduces their access to low cost timber. The result of this is that then firms have developed a highly competitive and secretive nature with one another. The reluctance to share information also stems from the fact that the information sharing firms cannot internalize the positive spillovers that they provide to other firms, nor do they have any assurance of reciprocation from the receiving firms and thus there is a further disincentive to share information with other firms. The result of this is that currently the firms end up timber cruising the same stands and thus duplicating effort. Since the firms generally have the same quality standards, they generally come to the same harvest or no harvest conclusion the majority of the time. This duplication of effort by each firm involved in the industry results in a much higher level of timber cruising effort expended on each stand in the area and much higher timber cruising costs for firms than if they were to share information; I have called this the multiple cruise effect.

The Timber cruising Model

The results of a literature review conducted for this study revealed that there has been little research in the area of timber cruising; this is especially true when it comes to competitive timber cruising among firms. The reasons for this stem from the fact that a sizeable proportion of the timber harvested in Europe and the United States is harvested on private land, in which case there is no competition and only one cruise is performed for inventory purposes. The remainder of the timber harvested in the United States, as well as in many parts of Europe, is publicly owned but is allocated through a direct auction sale system instead of the tenure agreement system currently used in Canada. In the case of an auction, the government agencies that manage the forests perform one cruise for inventory purposes and share that information with the firms bidding on the timber; thus only one cruise occurs on stands allocated through a direct auction sale system. The existence of competitive timber cruising and the multiple cruise effect is then rather unique to the tenure agreement forest resource allocation system that is widely used in Canada.

If one considers the nature of timber cruising, it is simply a search process comparable to an individual searching for a job. The most useful result, in terms of applicability to this study, which has been derived from research into job search models, is the notion of a stop rule. (Coughlin and Zaretsky, 1995) A stop rule defines the point at which an individual/firm discontinues their search for whatever it is they are searching for; this generally occurs at the point at which the limiting constraint is satisfied. (Brown et Al., 1985; Coughlin and Zaretsky, 1995) In Saskatchewan, forestry companies that hold annually renewable forest product permits are permitted to reserve and schedule forest stands for the following year's operations. This allowance forms the basis for the primary timber cruising investment constraint in this model as there is no incentive for firms to invest in timber cruising forest stands for which they cannot secure cutting rights. As such the firms will stop timber cruising in each period when they have found a volume of harvestable timber (TV) which is equal to their annual allowable cut volume (AAC).

In addition to the stop rule constraint, there are also a number of feasibility constraints that must be satisfied in order for a block to be harvested. The feasibility constraints that must be satisfied in order for harvesting of a block to be deemed feasible are related to minimum opening sizes, minimum utilization percentages, maximum hauling distance from mills, maximum distance from pre-existing road infrastructure, and minimum harvest volumes. Naturally, since the firms are profit maximizing, the economic goal is to minimize average timber cruising costs. This diverse combination of spatial constraints, volume based constraints, economic constraints, and qualitative constraints that are often governed by human decision making principles make modelling timber cruising an extremely complex problem. The problem is so complex, in fact, that without the use of advanced computer algorithms and programming techniques it would more than likely be almost impossible to develop a solvable model. Following this realization, a review of literature pertaining to the use of search heuristics in forestry related problems was conducted.

<u>The TS Method</u>

When reviewing the literature it was found that several other studies had applied search heuristics to a number of complex forestry related problems with the most interesting of these being the Tabu Search (TS) heuristic. Tabu Search is a unique local search framework that utilizes short term and long term memory structures to generate a search history and provide essential feedback on that history. The short term memory structures provide feedback on the previous moves during the search by making them “tabu” and ensuring that there is no repetition of previous moves (Gunn and Richards, 2003). This has the effect of eliminating duplication of effort from the system and when applied to our timber cruising model would ensure that the same stands are not cruised twice. The long term memory structures ensure that, in the case of multiple iterations, the same search path is not repeated. (Caro et Al. 1997) Performing multiple iterations is important because the TS heuristic does not achieve the known fully optimized solution in one iteration, but rather returns a local maximum or minimum which is near to the known optimal solution after each iteration. Generally a maximum number of iterations will be chosen by the researcher and the best solution from the group of iterations will be accepted as being the most optimal. In the case of our timber cruising problem, the solutions provided by each iteration represent different local maximum/minimum values that are attainable given the search path that is followed.

The history of the search that is generated in TS can also be used to develop a set of intelligent problem solving principles, this allows for the emulation and incorporation of human problem solving principles into our model (Gunn and Richards, 2000). This feature is extremely useful in the timber cruising model as it will allow us to emulate the decisions that would be made by a forester during the timber cruising process. The ability of the TS to solve complex optimization problems by simultaneously satisfying a combination of spatial and economic constraints is also an important feature (Caro et Al., 2006; Gunn and Richards, 2003; Greber and Laroze, 1997). This feature will allow us to combine the constraints that govern the timber cruisers decisions while at the same time satisfying the profit maximizing objectives of the firm. These features combined with the fact that there “no requirements for linearity, continuity, or convexity in objective functions or constraints” make the TS heuristic an attractive modelling tool for a combinatorial problem such as timber cruising (Gunn and Richards, 2003). Detailed discussion on the programming language and operations of TS have not been included in this paper as it is not within the scope of this discussion, but curious readers are referred to (Glover, 1990) for a more detailed description of the TS heuristic.

Due to the nature of our search problem it must be modelled in two phases. The initial phase is the search of GIS information to determine timber potential for reconnaissance work. GIS data obtained from Saskatchewan's Forest Inventory Database, which contains both spatial and biological information concerning the forest areas within the PAFMA will provide us with the data required for the first phase of the search. The second phase of the search is the reconnaissance portion of the timber cruising activity. It is during this phase that major decisions on harvestability of targeted stands are made by the forester. Consequently, this phase is much more resource intensive and most of the timber cruising costs are incurred here. The data for the second phase of the search will be a combination of GIS data used in phase one and the sampling data obtained by the foresters during reconnaissance work. To construct the two phase timber cruising search model which will be solved using the TS method we will begin by deriving our phase one feasibility constraints.

Phase One Feasibility Constraints:

(1) Minimum Opening Size of 10 hectares

Min(Open) = 10 ha

(2) Maximum Distance from Pre-existing Road Infrastructure

Max(Distance) = (B_r*V_i)/ARC

Where,

B_r = Budgeted Road Cost per Cubic Metre

V_i = Volume in Stand

ARC = Average Road Building Cost per km

(3) Maximum Hauling Distance to Mill

Max(Haul) = (B_h*V_i)/AHC

Where,

B_h = Budgeted Hauling Cost per Cubic Metre

V_i = Volume in Stand

AHC=Average Hauling Cost per km

Note: For Non-isolated stands in close proximity (<1km apart) total volume for each stand may be pooled to determine whether or not constraint (2) is satisfied.

If all of the phase one constraints are simultaneously satisfied it is determined that there is significant potential to timber cruise the area. Sample data obtained during the timber cruising process will then added to our database at which time phase two of our TS model will be utilized. The phase two feasibility constraints which determine whether or not a stand will be deemed harvestable are shown below. The utilization constraint and minimum opening size constraint values which will be used are based on this authors experience as a forester for one of the IO's from 2005 through 2008, and as such are deemed to be current. The remainder of the constraints are functions of the firm's budget allocations to the various activities in the timber cruising process.

<u>Phase Two Constraints</u>

(1) Minimum Utilization Percentage of 70%

$U \geq 70\%$

(2) Minimum Harvest Volume

$\mathrm{Min}(V_h) = M/(B_m)$

Where,

M = Expected cost of moving/relocating forestry operation

B_m = Budgeted moving cost per cubic metre

V_h = Harvestable Volume in Stand

(3) Maximum Distance from Pre-existing Road Infrastructure

$\mathrm{Max}(\mathrm{Distance}) = (B_r * V_h)/\mathrm{ARC}$

Where,

B_r = Budgeted Road Cost per Cubic Metre

V_h = Harvestable Volume in Stand

ARC=Average Road Building Cost per km

(4) Maximum Hauling Distance to Mill

Max(Haul) = $(B_h*V_h)/AHC$

Where,

B_h = Budgeted Hauling Cost per Cubic Metre

V_h = Harvestable Volume in Stand

AHC = Average Hauling Cost per km

(5)Minimum Opening Size of 10 hectares

Min(Open) = 10 ha

Note: For Non-isolated stands in close proximity (<1km apart) total volume for each stand may be pooled to determine whether or not constraints (2) and (3) are satisfied.

If the stand that is being cruised simultaneously satisfies all of the phase one and phase two constraints, the firm will make the decision to harvest the stand and if it does not simultaneously satisfy all of the constraints the firm will make a no harvest decision. The stand volumes (V_h) for each stand for which a harvest decision is made will be summed to derive the total volume of harvestable timber the firm has found during their timber cruising activities (TV_f). Timber cruising will continue only up until the point at which the stop rule of has been satisfied; this occurs at the point where the total harvestable timber found by a firm during their timber cruising activities (TV_f) is equal to the firm's annual allowable cut (AAC_f) Mathematically, this can be represented as:

Stop Rule: $\sum V_i = TV_f = AAC_f$

The Timber Cruising Cost Model

For ease of modelling it will be assumed that all of the IO's have equal annual allowable cuts, invest equal amounts in timber cruising, budget equal amounts to the same harvesting activities and have equal feasibility and utilization standards. Although this may seem to be a vast extension from the current situation it really is not that far off. There is some variance in the annual allowable cuts of the IO firms that engage in timber cruising, but it is not large enough to change the cost structure of the firms. The notion that they have similar cost structures is further supported by the fact that these competitive firms sell their products for similar prices in competing markets, compete for inputs in a small local market, operate similar sized mills in the same geographical area, and employ approximately the same level of technology in their operations. As such, it is felt that the assumptions above will still provide an accurate approximation of the current situation. The basic total cost model for timber cruising is a function of labour costs, aerial survey costs, equipment costs, timber cruising travel costs, and research camp costs. The total timber cruising cost that is derived below includes all phase one and phase two timber cruising costs.

Cost to Firm of Timber cruising a Geographical Area are Given By:

$TC_f = x_l * w_l + x_a * w_a + x_t * w_t + k + r$

where,

TC_f = total cost of timber cruising the geographical area

xl = number of forester labour hours

wl = forester wage rate

xa = number of hours in aircraft

wa = cost per hour for aircraft

xt = number of km travelled

wt = cost per km of travel

k = timber cruising equipment costs

r = research camp costs

Timber cruising Costs per Cubic Metre for Firm are Given by:

$AC_f = TC_f / TV_f$

Where,

TV_f=Total volume of merchantable timber cruised by firm

Assuming that the firms have been acting on the basis of profit maximization, the timber cruising cost optimization problem for the firm is given by:

$\text{Min } AC_f = (x_l*w_l + x_a*w_a + x_t*w_t + k + r)/TV_f$

s.t. $TV_f \leq AAC$

where,

$TV_f = \sum V_h$

and V_h

s.t. $U \geq 70\%$

$\text{Min}(V_h) = M/(B_m)$

$\text{Min}(\text{Open}) = 10$ ha

$\text{Max}(\text{Distance}) = (B_r*V_h)/ARC$

$\text{Max}(\text{Haul}) = (B_h*V_h)/AHC$

AC is chosen as the objective function instead of TC as it incorporates the total harvestable volume (TV_f) into the function being optimized. Inclusion of TV in our optimization problem is important because the central goal of the timber cruising firm is not just to minimize the cost of timber cruising all wood (regardless of whether or not it is deemed harvestable), but to minimize the timber cruising cost on the wood deemed harvestable (TV_f). Due to the presence of fixed costs in the form of research camp costs and timber cruising equipment costs, the above optimization problem solved using a Tabu search algorithm framework should return the AC value for the situation in which the stop rule has been initiated at which point TV_f equal AAC_f. As such we can calculate total costs for the firm (TCf) by multiplying the optimized AC value by TV.

Since information is not shared, we will assume that in the long run all of the firms will cruise the same stands and generate the same no cut decisions. As such, the industry cost (TC_i) for timber cruising the geographical area is given by the number of firms (n) multiplied by the value of each firms total timber cruising expenditure (TC_f).

$TC_i = n*TC_f$

Counter-factual Timber Cruising Cost Model

The lack of information sharing that results in duplication, often many times over, of effort by firms is not a problem that is unique to competitive timber cruising firms in forestry. This phenomenon is highly discussed in studies pertaining to the activities of firms engaged in innovation based research and development. These firms, much like the IOs in this study, are often highly competitive and have similar research objectives (Kamien et Al, 1992). Because of this they often make large independent investments in research which leads them to the same discovery, the result of this is that the level of expenditure on their discoveries end up being much higher than they would be if they had shared information (Kamien et Al, 1992; Hagedoorn et Al, 2006). Unfortunately, in most cases, there is no incentive for the firms to share as they only recognize the marginal benefits that they receive from conducting research and sharing their results, which is equivalent to the marginal benefit that they receive from not sharing their results. The positive spillovers from knowledge transfer are only captured by the firms receiving the knowledge and although this shifts the social marginal benefit curve to the right, it has no impact on the sharing firms individual marginal benefit function; and thus no impact on the firm's behaviour. Despite this lack of incentive, many firms engaged in innovation based R&D have found an efficient solution, which ensures 100% information transfer, removes the possibility of duplication, and results in maximized firm profits. This solution has been found through the creation of research joint venture cartels (Kamien et Al, 1992).

In research joint venture cartels, firms cooperatively fund and engage in research that they would have otherwise undertaken independently. By sharing the knowledge that firms already have, pooling research resources, and eliminating duplication they are able to greatly decrease the cost of the ideas that they generate (Hagedoorn et. Al, 2006; Kamien et Al, 1992). In addition, the cooperative research allows the firms to pool risk and spread it evenly among the participants; this has the effect of increasing the firm's incentives to invest in R&D (Hagedoorn et Al., 2006).

In the counter-factual version of the IOs' timber cruising activity, firms would cooperatively timbercruise and share 100% of their information. Each firm would invest an equal amount in timber cruising and cooperatively plan their timber cruising with the other firms, preferably through a centralized forestry research department. As a result of the cooperative planning each stand would only be timber cruised once and the resulting harvestable stands would be divided equally among the participating firms. One potential issue that may be raised by firms is that not all of the stands that are found to be harvestable are going to be of equal utilization and that there is a potential for inequality in terms of research dollars expended per cubic metre of utilizable raw timber received. In the case of the PAFMA IOs, the intent is to solve this problem through the extension of the cooperative model to timber harvesting, log processing, and log distribution. The quantities of utilizable material would then be equalized in the process of distributing utilizable logs equally to the firms.

The counterfactual model would lower both industry and firm timber cruising costs as duplication of effort would be eliminated and thus less money would be invested in timber cruising the same geographical area. The proposed model would also lower timber cruising risk (the probability of an unsuccessful cruise) for each firm by pooling the risk and dividing it equally among the firms. The differs from the factual case in that the lack of information sharing between the firms results in a situation in which all firms incur the maximum level of timber cruising risk by timber cruising all blocks independently. The timber cruising cost framework for the counterfactual case is shown below.

Industry Timber Cruising Costs are Given by:

$TC_i = x_l*w_l + x_a*w_a + x_t*w_t + k + r$

where,

TC_i=total cost of timber cruising the geographical area

xl= number of forester labour hours

wl=forester wage rate

xa=number of hours in aircraft

wa=cost per hour for aircraft

xt=number of km travelled

wt=cost per km of travel

k=timber cruising equipment costs

r=research camp costs

Since the industry is working cooperatively and duplication of effort has been eliminated, the TC function for individual firms in the factual case can now be represented in a form similar to the TC function for industry in the counterfactual case. The timber cruising cartel that has been formed by the firms is still governed by the profit maximizing nature of the firms and as such the objective function will be similar to that in the factual case. The optimization problem which will be solved using a Tabu search method is given by:

Min $AC_i= (x_l*w_l + x_a*w_a + x_t*w_t + k + r)/TV$

s.t. $TV_i \leq AAC_i$

where,

$TV_i=\sum V_h$

and V_h

s.t. $U \geq 70\%$

$Min(V_h)= M/(B_m)$

Min(Open)= 10 ha

$Max(Distance)= (B_r*V_h)/ARC$

$Max(Haul)=(B_h*V_h)/AHC$

It should be noted that in this case the annual allowable cut given by AAC_i is equal to the summation of the annual allowable cuts of the firms in the counterfactual case. Total industry costs are easily calculated by multiplying the optimized AC_i value by the total volume of harvestable timber (TV_i) found during the timber cruising cartels cruise. Given that all of the firms involved in the timber cruising cartel share the expenses and results of the timber cruise equally their total timber cruising costs are given by:

$TC_f=(TC_i/n)$

Where n= the number of firms operating in the geographical area

The obvious result of cooperative timber cruising and the elimination of duplication is that the inefficiencies that are present in the current competitive timber cruising system are eliminated. The industry efficiency gain is given by:

Efficiency Gain=$TC_{factual} - TC_{counter\text{-}factual}$

Efficiency Gain=(n* L+K+G+A+C)-(L+K+G+A+C)

Efficiency Gain=(n-1)*(L+K+G+A+C)

The individual efficiency gain realized by firms is then given by:
Efficiency Gain Realized by Individual Firms=[(n-1)*(L+K+G+A+C)]/n

Conclusions

The Tabu Search Method appears to provide a very useful framework for deriving timber cruising constraints. Further, the ability of the TS Method to incorporate the spatial, economic, and stop rule constraints and to incorporate human problem solving techniques into a mathematical optimization framework has resulted in the creation of a model that is an accurate representation of the current timber cruising cost model. The incorporation of collective action into the timber cruising cost model in the counterfactual case reveals that in theory there is potential to extract significant efficiency gains from cooperative timber cruising or the formation of a timber cruising cartel. Moreover, optimization of the counterfactual timber cruising cost model using the TS method results in the maximized profits for IO firms and the IO industry as a whole. As such, it appears that elimination of the multiple cruise effect through cooperative timber effect has the potential to reduce timber cruising costs for IO firms and to increase the competitiveness of the individual firms. Although, this study does not use empirical data to quantify the economic significance of the efficiency gains, it is expected that the gains will continue to rise as the price of inputs continues to rise and as the supply of easily accessible, low cost timber continues to fall. In future studies of this problem, I hope to fit empirical data to the model specified above, as well as several different model specifications, and test the models to determine if the model I have specified best fits the data.

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